

CALIFORNIA ENERGY COMMISSION'S

Public Interest Energy Research

1999 Annual Report



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California Energy Commission

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David A. Rohy, *Vice Chairman*

Michal C. Moore, *Commissioner*

Robert A. Laurie, *Commissioner*

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The Resources Agency of California

Mary D. Nichols, *Secretary*



P500-00-001



CALIFORNIA ENERGY
COMMISSION

February 9, 2000

Members of the Senate Energy, Utilities and Communications Committee
Members of the Senate Budget and Fiscal Review Committee
Members of the Senate Appropriations Committee
Members of the Assembly Utilities and Commerce Committee
Members of the Assembly Budget Committee
Members of the Assembly Appropriations Committee
California State Capitol Building
Sacramento, California 95814

**Re: The California Energy Commission's 1999 Annual Report Concerning the
Public Interest Energy Research Program**

Dear Members:

In accordance with Public Resources Code Section 25620.8, the California Energy Commission hereby transmits its second Annual Report to the Legislature concerning the Public Interest Energy Research (PIER) Program, for the period January 1 through December 31, 1999. As reflected in this Annual Report, the Commission has fully implemented the PIER Program. Recent legislation across the nation shows that California's PIER Program is serving as a model for many other states.

This Annual Report provides the following information: (1) a brief background and overview of the program, (2) a current status of the program, including *all funding awards made by the Commission as of December 31, 1999*, and (3) the Commission's recommended future direction for the PIER Program. The report specifically includes all required information on the "names of award recipients, the amount of awards, the types of projects funded...and recommendations for improvements in the program." However, since the projects funded during the second year of the PIER Program are multi-year projects and are not yet complete, the required annual "evaluation of the success of any funded projects" will be provided in subsequent Quarterly and Annual Reports on the PIER Program.

This document meets the reporting mandates of the 1999/00 Budget Act (Item 3360-001-0381) by providing two mandated project listings in Appendix A. The first is an itemized list for projects awarded funding in 1999 broken down by program area—including a project description, award amount, proposed outcomes, and project status. The second is an itemized list for projects awarded funding in 1998 broken down by program area—including a project description, award amount, proposed outcomes, and actual outcomes.

Should you have questions or comments concerning this report, please feel free to contact Tim Schmelzer, Acting Energy Commission Director of Governmental Affairs, at 654-4942.

Respectfully submitted,

A handwritten signature in black ink, reading "David A. Rohy".

DAVID A. ROHY, PH.D.
Vice Chairman and Presiding Member
Research, Development and
Demonstration Committee

A handwritten signature in black ink, reading "Robert A. Laurie".

ROBERT A. LAURIE
Commissioner and Associate Member
Research, Development and
Demonstration Committee

cc: California Legislative Analyst Office



P I E R

Public Interest Energy Research

CALIFORNIA ENERGY COMMISSION

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Executive summary

Background Regarding the PIER Program

Before the restructuring of California's electricity industry in 1996, ratepayer-funded energy-related research, development and demonstration (RD&D) projects were primarily conducted by the State's regulated utilities. Energy-related public interest RD&D was a key component of the rate structure mandated by the California Public Utilities Commission (CPUC) for the investor-owned utilities. During this period, California led the nation in developing and deploying a wide range of innovative energy technologies and services that were environmentally sound and saved ratepayers billions of dollars through improved generation and/or end-use efficiencies.

In 1996, California significantly restructured its electricity services industry through the enactment of Assembly Bill (AB) 1890. In AB 1890 the Legislature expressly determined that those RD&D activities which serve a broader public interest "should not be lost in the transition to a more competitive environment." To ensure continued funding for energy-related public interest RD&D, the Legislature authorized the collection of a non-bypassable surcharge on the retail sale of electricity of at least \$62.5 million annually to provide for these "public goods" efforts.

Recognizing the California Energy Commission's longstanding and widely acknowledged leadership role in energy-related RD&D activities, the Legislature further directed the CPUC to transfer specified surcharge funds for this public interest energy research (PIER) program to the Energy Commission. In accordance with these directives, in 1997 the CPUC determined that for the period from January 1, 1998 through December 31, 2001, at least \$61.8 million annually should be transferred to the Energy Commission's PIER Program Trust Account. These funds will be used to support those public interest RD&D activities that would not otherwise be adequately funded by the competitive or regulated markets.

To effectively implement its responsibilities for public interest research, the Energy Commission developed a RD&D Strategic Plan for the PIER Program. After conducting a series of statewide collaborative public hearings and workshops to gather input from various stakeholders and interest groups, the Commission adopted its RD&D Strategic Plan in 1997. This plan provides the framework for one of the nation's leading public interest energy research



photo courtesy of DOE/NREL

programs, and other states are now actively looking at the PIER Program as a model for continuing public interest research in a restructured electric services industry.

In October of 1997, Senate Bill (SB) 90 was enacted into law. This legislation further defined the PIER Program by identifying the key subject areas for funding and by providing specific administrative and expenditure criteria for the PIER Program.

Current Status of the PIER Program

The current status of the various functions of the PIER Program, as of December 31, 1999, is set forth below.

Transition Solicitation RD&D Projects Completed in 1999

In 1998, the Commission awarded approximately \$17 million to 39 separate “transition” RD&D projects covering the six PIER program areas. These projects were selected to preserve the benefits of the most promising ongoing public interest RD&D efforts conducted by investor-owned utilities before

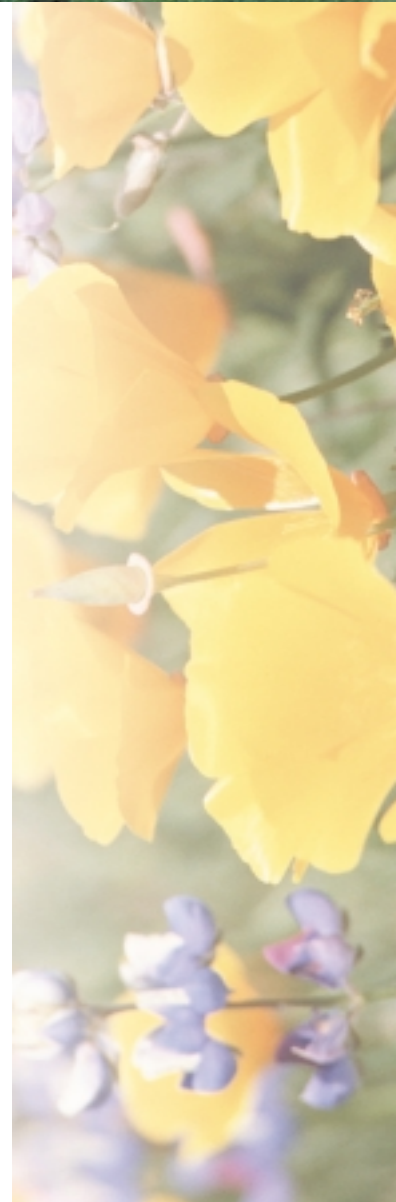
the onset of electricity restructuring. Of these 39 projects, 37 were completed in 1999, one project was cancelled, and one project has been extended until 2001. Benefits of selected Transition projects are presented below.

Realized and Expected Project Benefits

The PIER Program conducts public interest energy research that improves the quality of life for California’s citizens. Projects are funded in the following six PIER Program Areas. Examples of realized public benefits are listed for these program areas.

Buildings End-Use Energy Efficiency

- A more effective method of testing for duct leakage will improve thermal distribution system performance in buildings, leading to reduced energy costs and increased comfort to the end user in both new and existing homes.
- Four simplified commissioning and diagnostic tools will make building commissioning less expensive and easier





to do, which should result in more buildings being commissioned and consequently provide significant energy cost reductions through more efficiently operating buildings. Use of these simplified tools will also lower maintenance costs, extend equipment life, reduce equipment failures, and improve indoor air quality and comfort.

Industrial/Agricultural/Water End-Use Energy Efficiency

- Successful testing of ozone-treated water used as a disinfectant in poultry meat production will allow water recycling in poultry production as well as significantly reduce wastewater treatment costs. Ozone is generated using electricity.
- New energy-efficient water management practices will result in more efficient water use in California's vineyards.
- Lawrence Berkeley National Laboratory (LBNL) successfully tested an energy-efficient low air volume fume hood which reduces the volume of consumed air by over 50 percent and contains contaminants better than do traditional hoods. LBNL has found a commercial partner for commercial testing and eventual production.

Renewable Energy

- A project with Edison Technologies Solutions resulted in the development and installation of photovoltaic (PV) systems in Southern California, including facilities at the Monterey Hills School in South Pasadena, the Huntington Library in San Marino, and the PV powered Ferris wheel at the Santa Monica Pier. The installed PV systems saved California ratepayers over \$1.5 million in new distribution lines.

Environmentally-Preferred Advanced Generation

- A project conducted by San Diego Gas & Electric Company successfully operated a 75 kW integrated pressurized molten carbonate fuel cell power plant technology

at the Marine Corps Air Station Miramar in San Diego. The test verified significant environmental benefits of the new technology and proved its viability, reliability, and durability. This technology will have distributed generation applications with greatly reduced air emissions and higher efficiency than existing state of the art technologies.

- A second project conducted by San Diego Gas & Electric Company successfully demonstrated and evaluated a less expensive reliable solid-state interconnection system for distributed energy technologies. The demonstration showed how the utility grid could now easily accommodate new smaller sized distributed generation technologies to enhance electric system reliability and increase overall flexibility of the grid. Based on this demonstration, a distributed energy resource supplier is planning to integrate this device into their commercially packaged generation system.

Energy-Related Environmental Research

- Based on the RD&D results from a PIER-funded electrotechnologies project, the Orange County Water District has decided to build a \$275 million treatment facility which will recharge the groundwater basin with reclaimed water to supply nearly two-thirds of pending demand. The filtration methods being developed will also reduce groundwater salinity by more than 13 percent, which will reduce costs associated with damages caused by salinity.

Strategic Energy Research

- Results from a PIER-funded electric system seismic safety and reliability project have already been incorporated by a major California utility in their risk management practices. This project improves the reliability of California's electricity by reducing the vulnerability of the electric transmission and distribution system to damage caused by a major earthquake, by

maintaining power in an area affected by an earthquake, and by promoting the rapid recovery of electric service.

- Another project improves the reliability and capability of California's transmission and distribution system by developing a stronger and lighter conductor to replace aging and overloaded power lines. Many miles of California's overhead electricity transmission lines have reached the end of their service lives or are being stressed beyond their design limits due to load growth and heavy power transfers across longer distances.

Summary of 1999 PIER Awards listed by Funding Method and Administration

During 1999, the Commission used three different methods to select and fund public interest RD&D projects under the PIER Program. These methods are competitive awards, sole-source contracts, and interagency/intergovernmental agreements. During 1999, the Commission approved public interest energy research awards totaling approximately \$46 million through the following funding methods:

- Twenty-one competitive awards totaling \$17.2 million¹.
- Four sole-source contracts totaling \$16.7 million.
- Four interagency/intergovernmental agreements totaling \$12 million.

On average, every PIER research dollar is being matched by \$4.89 from PIER's research partners. The \$46 million in PIER awards will be matched with approximately \$225 million in other cash and in-kind matching funds,

thus providing approximately \$271 million in total funding for these public interest energy research projects.

Funding Research through PIER Program Areas

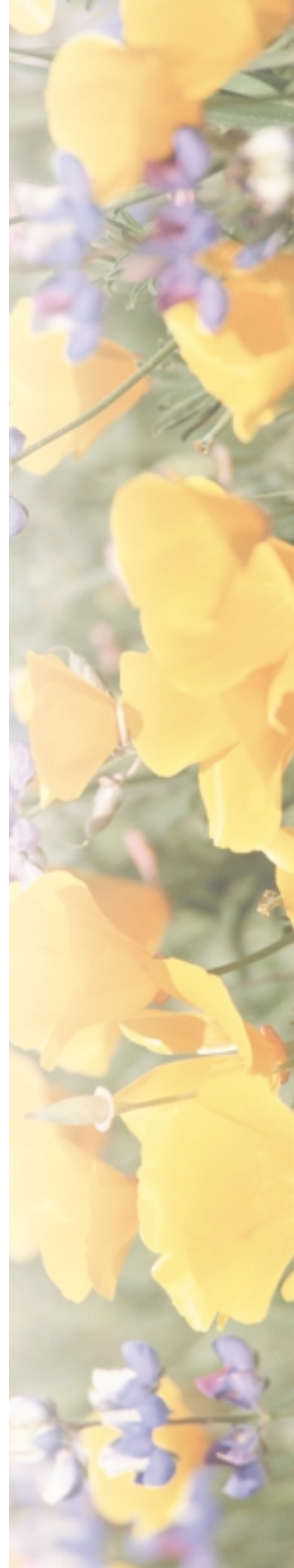
During 1999, the Commission approved public interest energy research awards totaling \$33.9 million directly through the PIER Program Areas². The funding methods used include one competitive solicitation, two sole source awards, and four interagency/intergovernmental agreements. A second competitive solicitation that was released in 1999 will make awards early in 2000. Appendix A provides a complete compendium and description of all projects funded in 1999.

Following is a summary of 1999 research funding activity administered directly by PIER program area leads:

- *The Buildings End-Use Energy Efficiency Program Area* completed one programmatic solicitation totaling \$17.3 million in Commission awards and leveraging \$9.5 million in matching funds. The \$17.3 million will be allocated over three years in the following amounts: \$5.7 million for 2000, \$5.8 million for 2001, and \$5.8 million for 2002. Under the Buildings Program, the Commission also awarded a \$60,000 two-year interagency collaborative research funding agreement with the Center for the Built Environment that leveraged approximately \$1 million in matching funds.
- *The Industrial/Agricultural/Water End-Use Energy Efficiency Program Area* received Commission approval for an 18-

¹ Eighteen of these awards were made through the Energy Innovations Small Grants Program which is funded by a \$5 million interagency agreement awarded by the Commission in 1998 to the California State University Institute.

² This total does not include awards made under the management of PIER's three other administrative leads: the lead for the Energy Innovations Small Grants Program, the lead for the Electric Power Research Institute award, or the lead for the Gas Research Institute award. 1999 PIER awards administered by these three leads also provide benefits under the six PIER Program Areas. The 1999 PIER awards administered by these three leads are discussed under their respective headings in this report.





month, \$1.8 million interagency agreement with the University of California, Davis (UC Davis). This agreement will fund research to improve energy efficiency in the agricultural industry. Consortium members are providing \$2.1 million in matching funds.

- *The Renewable Energy Technologies Program Area* released a \$1.3 million competitive negotiation solicitation for small-scale/modular distributed biomass power projects. Notice of Awards will be made in early 2000.
- *The Energy-Related Environmental Research Program Area* received Commission approval for a \$3 million interagency agreement with the California Air Resources Board to conduct the Central California Ozone Study (CCOS). This study will develop a better understanding of how thermal power plant plumes contribute to regional air quality problems in Central California. A major objective is the development of workable inter-basin/inter-pollutant offset trading rules for the Central California region. The Commission's contribution leverages approximately \$9 million for the ozone study and another \$28 million for a complementary particulate study.
- *The Strategic Energy Research Program Area* received Commission approval for a \$100,000 sole-source award to co-fund a project to analyze the power quality impacts of large single-phase residential loads, such as electric vehicle chargers, computer equipment, appliances, and HVAC to residential distribution systems. The Commission also approved a \$4.5 million sole-source contract with PG&E and the U.C. Berkeley's Pacific Earthquake

Engineering Research Center to conduct seismic research in several critical electric system research areas. These funds will be expended over a three-year period and will be matched with approximately \$2.6 million from CalTrans and additional funding from the U.S. Geological Survey and the Federal Emergency Management Agency. The Strategic Energy Research Program Area also received Commission approval for a \$7.2 million intergovernmental agreement to support a three year research program conducted by Lawrence Berkeley National Lab on behalf of the Consortia for Electric Reliability Technology Solutions. This award leverages \$11.8 million over three years. The goal of this project is to maintain and enhance electric system reliability and improve public access to the benefits of electric restructuring.

Funding Projects through the Energy Innovations Small Grants Program

In 1999, the Commission completed two rounds of solicitations for the Energy Innovations Small Grants Program, awarding \$1.3 million to the 18 most promising proposals³. Awards were made in four of the six PIER Program Areas. A third solicitation released in 1999 resulted in 70 additional proposals that were evaluated and scored. The RD&D Committee intends to recommend funding for 11 proposals from this third solicitation in early 2000.

Funding Projects through collaborative research funding with the Electric Power Research Institute

In 1998, the Commission approved an initial one year \$1.5 million collaboration with EPRI, focused on funding collaborative research in seven key areas for California. In 1999, the Commission unanimously

³ These 1999 grants are being funded by a \$5 million interagency agreement awarded by the Commission in 1998 to the California State University Institute.

extended the partnership through 2000, augmenting the funding with \$11.7 million, to include 20 additional research areas. The Commission's collaborative research funding leverages 13 dollars for every one dollar of Commission funding, resulting in \$152.8 million in matching funds from other EPRI research partners.

Supporting Projects through collaborative research funding with the Gas Research Institute

In June 1999, the Commission approved (with the Legislature's concurrence) an 18-month sole source contract for extending collaborative research funding with GRI. The \$365,100, collaborative research funding supports five program areas including advanced fuel cells, distributed generation, industrial waste processing, high efficient industrial combustion, and commercial cooling/heating pump applications. The Commission's collaborative research funding leverages \$7.3 million in matching funds from other GRI research partners.

PIER Program Administration Improving PIER Program Efficiency

The Commission now uses customized contract terms and conditions which recognize relevant differences among client groups including universities, utilities, small businesses, and large businesses. These customized terms and conditions have dramatically reduced the time and effort required for executing contracts. In addition, a simplified invoicing process has been developed and is being used with all PIER contracts, and the requirements for extensive back-up information have been eliminated and replaced by an audit program conducted by the Commission.

In 1999, the Commission adopted "competitive negotiations" regulations to allow the Commission to negotiate the details of competing proposals to improve

the quality of proposals. The Commission also adopted regulations in 1999 that detail criteria to award PIER contracts on a sole or single source basis.

Technology Transfer

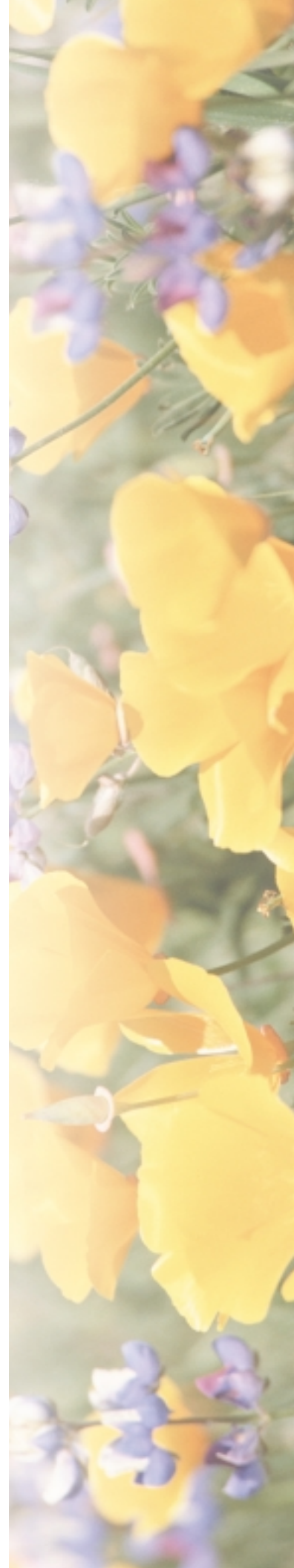
In October of 1999, the Commission sponsored a major PIER conference, *Energy Innovations '99: Sharing the Benefits of California's Research Investment*. This conference facilitated the exchange of relevant information and ideas among researchers, technology users, and other interested parties from throughout California, the nation, and the international community.

A PIER Program informational exhibit and a PIER Program brochure were developed to provide an overview of the PIER-funded programs. The exhibit and brochure helped transfer program information at the *Energy Innovations '99* conference and will be used for technology transfer at future public forums.

Future Program Directions

In 2000, the Commission will build on its successful first two years of the PIER Program and maximize the value of the program by:

- Increasing the "purchasing power" of available PIER funds by selectively entering into major co-funded RD&D efforts with the federal government, other states, and non-profit organizations;
- Carefully and efficiently managing all existing PIER contracts to ensure that ratepayer funds are well spent and that maximum public value is obtained from these contracts; and
- Effectively transferring the results of the various PIER-funded RD&D efforts into the market.





PIERannualreport

I. Overview of the Program

A. Background

In 1996, California adopted far-reaching legislation which deregulated much of this State's electric services industry (1996 Statutes, Chapter 854, hereinafter "AB 1890"). Article 7 of AB 1890 was enacted to ensure that the benefits obtained from important public purpose programs—such as public interest research, development and demonstration (RD&D)—would not be lost in the newly deregulated environment. As a result, Public Utilities Code Section 381 requires that, starting on January 1, 1998, at least \$62.5 million be collected annually through California's electric investor-owned utilities (IOUs) to fund energy-related public interest RD&D activities "*not adequately addressed by competitive and regulated markets.*"

The Commission is authorized in AB 1890 to receive and administer such funds as designated by the California Public Utilities Commission (CPUC) for the conduct of public interest RD&D, subject to administration and expenditure criteria established by the Legislature. In 1997, the CPUC determined that at least \$61.8 million annually should be transferred from the major IOUs to the Commission for specified public interest energy research (D.97-02-014)¹. These funds

are subject to the administrative and expenditure criteria adopted by the Legislature in 1997 (1997 Statutes, Chapter 905, hereinafter SB 90), which are contained in Public Resources Code Section 25620 *et seq.*

B. Developing a Strategic Plan for Public Interest Energy Research

Beginning in 1996, the Commission conducted an extensive public process to collect input and recommendations from a wide variety of stakeholders and interested citizens on how to best administer the Public Interest Energy Research (PIER) Program authorized in AB 1890. An advisory group, consisting of more than 70 separate organizations and individuals concerned with public interest RD&D issues, held a series of public workshops throughout the State and provided detailed comments and recommendations to the Commission.

Based on this extensive public input, the Commission adopted a report entitled *Strategic Plan for Implementing the RD&D Provisions of AB 1890*, (P 500-97-007, June 1997). This report includes a mission statement and objectives for the PIER Program, as well as a strategic plan for

¹ In 1998, a small IOU, Bear Valley Electric Company (also known as Southern California Water Company), sought and received CPUC authority to contribute \$56,000 annually to the PIER Program.

administering the program. It will be updated and revised periodically, as needed, in the future.

C. Mission Statement for the PIER Program

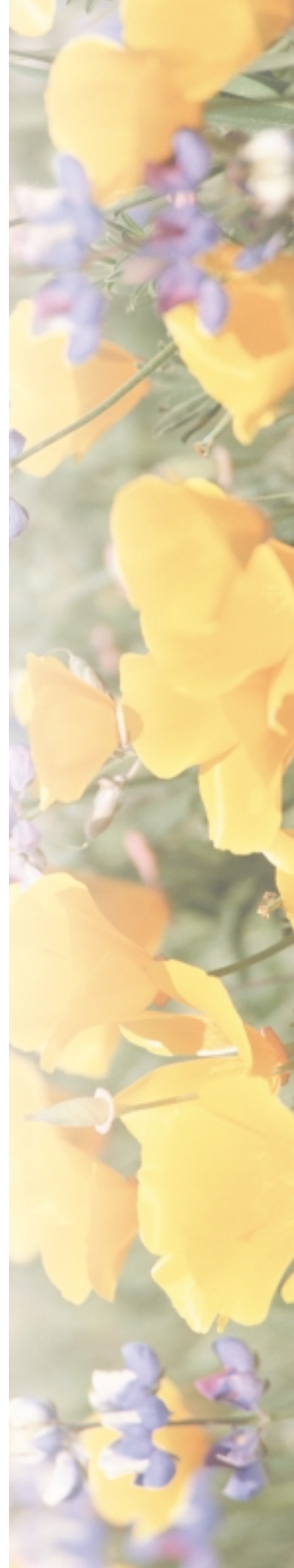
The Commission's RD&D Strategic Plan provides that:

The mission of the Public Interest Energy Research Program is to conduct public interest energy research that seeks to improve the quality of life for California's citizens by providing environmentally sound, safe, reliable, and affordable energy services and products. Public Interest Energy Research includes the full range of research, development, and demonstration activities that will advance science or technology not adequately provided by competitive and regulated markets.

D. Objectives of the PIER Program

To achieve the goals set forth in the PIER Program's mission statement, the Commission also adopted specific objectives for the PIER Program. These objectives are as follows:

1. Develop and implement a robust public interest RD&D portfolio of projects that addresses California's energy needs and initially focuses on end-use energy efficiency, environmentally preferred advanced generation, renewable energy technologies, and environmental issues. This portfolio shall also provide strategic energy research. The public interest portfolio would include public interest system reliability RD&D not covered by the CPUC.
2. Create and maintain a public interest RD&D program that balances risks, time-frames, and public benefits in a manner consistent with California's energy policies.
3. Create a public interest RD&D knowledge base and disseminate information that will allow citizens, businesses, government, and other entities to make informed decisions concerning energy technologies and services.
4. Ensure that the public interest RD&D program is connected to the market by (a) collaborating with market and public interest stakeholders to determine research and market needs during program planning, (b) incorporating the assessment and understanding of market needs and technology status into appropriate phases of RD&D projects, and/or (c) transferring public interest RD&D results into the marketplace through partnerships and other actions.
5. Ensure public input and accountability for the public interest RD&D program by (a) conducting an open and flexible planning and decision-making process which involves stakeholders in both planning and implementing the program, (b) using advisory committees and expert panels to guide programs and evaluate project proposals, and (c) using an independent group for overall program review and evaluation.
6. Ensure the efficient administration and stewardship of public interest RD&D funds by (a) implementing a streamlined project acquisition and funding process, (b) using prescribed project evaluation criteria to select projects based on merit, (c) leveraging limited public interest RD&D funds through public/private partnerships to the extent possible, (d) managing projects flexibly and effectively, and (e) avoiding excessive overhead costs.
7. Provide leadership and coherence for California's public interest RD&D efforts by (a) coordinating with public and private RD&D entities, and (b) integrating this effort with the Energy Efficiency/Renewables programs and other public interest energy efforts.





E. PIER Program Areas

The subject areas for the PIER Program are defined in Senate Bill No. 90:

The program shall consist of a balanced portfolio that addresses California's energy and environmental needs, technology opportunities, and system reliability. To achieve balance, the Commission shall actively solicit applications for the under-represented subject areas of end-use energy efficiency, renewable technologies, and environmental enhancements. The portfolio shall include the relevant core subject areas of environmental enhancements, end-use efficiency, environmentally-preferred advanced generation technologies, renewable technologies, and other strategic energy research, including public interest system reliability research, demonstration, and development not adequately addressed by the Public Utilities Commission.

The Commission's RD&D Strategic Plan recommends that planning efforts for the PIER Program be undertaken at levels corresponding to the program's organizational structure and funding areas. In 1998, the Commission established the following six PIER Program funding areas:

- Residential and Commercial Buildings End-Use Energy Efficiency
- Industrial/Agricultural/Water End-Use Energy Efficiency (Process Energy)
- Renewable Energy Technologies
- Environmentally-Preferred Advanced Generation
- Energy-Related Environmental Research
- Strategic Energy Research

Interdivisional teams led by staff experts have been formed for each of the six program areas listed above. Each team is responsible for planning and implementing the RD&D activities needed to meet specific PIER goals and deliver results in the program areas in question. As with all aspects of the PIER

Program, this effort is conducted with review and input from the Policy Advisory Council, focus groups, stakeholders, and interested members of the public. Current and future program plans will be periodically reviewed and evaluated—both internally and externally—to recognize the changing roles and scope of the program.

II. Current Status of the PIER Program

The current status of the various functions of the PIER Program, as of December 31, 1999, is set forth below.

A. Policy Development and Planning

AB 1890, SB 90, and the Commission's RD&D Strategic Plan have identified the essential State policies for energy-related public interest research that are to be carried out through the PIER Program. In turn, the results from the PIER Program are expected to provide input for future State energy policies.

In addition, a Policy Advisory Council provides ongoing advice to the Commission's RD&D Committee regarding the effective implementation of the PIER Program. The Council is comprised of a group of high level representatives from industry, academia, research institutions and various stakeholder associations. The Council held three meetings in 1999. During the January meeting, the Council reviewed the draft research plans of the six PIER Program areas. At the June meeting, the Council reviewed the program area funding proposals. During the October meeting, the Council reviewed the implementation of the program area funding proposals.

A list of the members of the Policy Advisory Council is attached in Appendix C.

B. Transition Solicitation RD&D Projects Completed in 1999

In 1998, the Commission awarded approximately \$17 million to 39 separate "transition" RD&D projects covering the six PIER program

areas. These projects were selected to preserve the benefits of the most promising ongoing public interest RD&D efforts conducted by investor-owned utilities before the onset of electricity restructuring. Of these 39 projects, 37 were completed in 1999, one project was cancelled, and one project has been extended until 2001. Project results are described in detail in Appendix A, and selected project benefits are presented below.

C. Program Area Issues and Realized and Expected Project Benefits

The PIER Program conducts public interest energy research that improves the quality of life for California's citizens. There are five overall objectives of PIER project funding:

1. Improve energy cost/value of California's electricity
2. Improve environmental and public health costs/risk of California's electricity
3. Improve reliability/quality of California's electricity
4. Improve safety of California's electricity
5. Maximize market/economy connection

These overall PIER funding objectives are implemented by selecting and supporting projects in the following six PIER Program Areas (listed with their public benefits):

Residential and Commercial Buildings

End-Use Energy Efficiency: increasing health, comfort, and productivity in buildings through energy efficiency, reducing consumer energy expenditures, and increasing state-wide and regional economic benefits.

Industrial/Agricultural/Water End-Use

Energy Efficiency: increasing energy efficiency and reducing emissions and manufacturing costs for California industries, agriculture, and municipal water and wastewater systems.

Renewable Energy Technologies:

increasing energy diversity, improving environmental quality, improving management of natural resources through the use of indigenous energy resources, protecting of public health and safety, and increasing benefits to local and regional economies.

Environmentally-Preferred Advanced

Generation: increasing cost savings to energy consumers, improving environmental quality, and reducing fuel consumption.

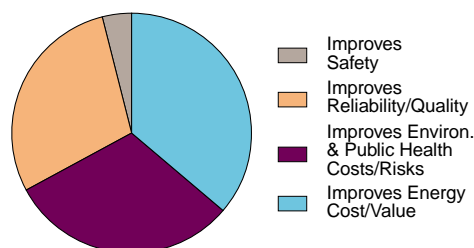
Energy-Related Environmental

Research: improving scientific understanding and/or addressing the environmental effects and costs of energy production, delivery, and use in California.

Strategic Energy Research: improving electric system reliability (concerning electricity supply, conversion, transfer or consumption); improving overall system efficiency; reducing system-wide environmental impacts; and improving products and services for electricity customers.

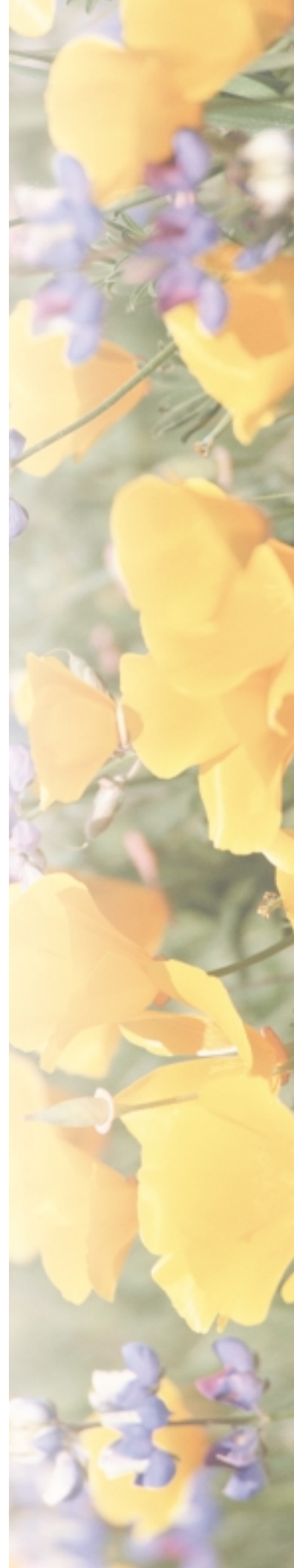
Critical public interest issues and technical goals and objectives have been identified for each program area. These issues and goals are used as guides in selecting projects that are most likely to create the above-stated public benefits. Summaries of the program area issues and realized and expected public benefits are presented below.


Proportion of Projects Addressing PIER Program Funding Objectives*



* Based on all projects funded in 1998 and 1999, excluding projects from the Energy Innovations Small Grants Program.

Note: All selected projects address the PIER Program objective of maximizing market/economy connection.





Buildings End-Use Energy Efficiency Issues, Successes and Outlooks

The Buildings Program Area includes new and existing buildings in both the residential and non-residential sectors. The Program seeks to decrease building energy use through research that will improve building performance evaluation methods and develop and improve building energy practices, strategies, tools, and technologies. In 1999, a final draft of a Buildings Program Area plan was developed which identified program issues and goals as well as strategies for meeting these goals. Four major issues motivating energy efficiency RD&D for California buildings have been identified:

- Energy consumption is increasing in hotter, inland areas as new building construction increases in these areas.
- Current development of energy efficient products and services does not adequately consider non-energy benefits such as comfort, productivity, durability, and decreased maintenance.
- Building design, construction, and operation of energy features can affect public health and safety.
- Investment in energy efficiency affects building and housing affordability and value, and the State's economy.

Examples of public benefits realized from two Transition Solicitation projects in 1999:

Residential Thermal Distribution Systems

- Developed an improved duct leakage test method to encourage the use of reliable testing to improve thermal distribution system performance. This development will lead to reduced energy costs and increased comfort to the end user in both new and existing homes.
- Developed an improved longevity testing method for duct sealants to increase the use of functional and reliable duct sealants. Benefits include improved reliability of

sealants used in the marketplace that will reduce energy costs.

- Validated the viability of downsizing equipment in conjunction with duct system upgrades to improve overall system efficiency. Benefits include reducing system equipment oversizing by approximately 25 percent, which reduces first costs and operational costs.

Improving the Cost Effectiveness of Building Commissioning using New Techniques for Measurement, Verification and Analysis

- Reduced the cost and complexity of building commissioning through developing four simplified tools. These tools make building commissioning less expensive and easier to do, which should result in more buildings being commissioned. Increased building commissioning will result in significant energy cost reductions through more efficiently operating buildings. Use of these simplified commissioning and diagnostic tools will also lower maintenance costs, extend equipment life, reduce equipment failures, and improve occupant comfort and indoor air quality.
- Retro-commissioning just one percent of all U.S. commercial buildings larger than 25,000 square feet could result in \$46 million in annual energy savings. The work done through this contract will facilitate wider use of commissioning.

Examples of public benefits anticipated in 2000:

Looking forward to anticipated achievements in 2000, three new programmatic contracts will be developed and initiated. The intent of these contracts is to achieve the Buildings Program Area goals through research programs that include multiple interrelated projects. The programmatic approach will accelerate advancements in science and technology by organizing teams of experts who can cut across company boundaries to resolve issues. This approach will encourage

researchers to work collaboratively, reduce duplication of effort, and create added research value through coordination and information sharing. The three planned programs are:

High Performance Commercial Building Systems

The goal of this program is to develop and deploy a set of energy saving technologies, strategies, and techniques, as well as improve processes for designing, commissioning, and operating commercial buildings, while improving health, comfort, and performance of occupants. The program aims to reduce electricity use by 22 percent in the California commercial sector by 2015.

Energy Efficient and Affordable Small Commercial and Residential Buildings for a Growing California

This program will develop and demonstrate technologies designed to make California's small commercial, institutional, and residential buildings more energy efficient, healthier, and more comfortable. These benefits will be achieved through developing automated commissioning and diagnostic tools, developing advanced load management strategies and controls, developing alternative cooling technologies, and developing alternative construction techniques.

Integrated Energy Systems

This program will focus on developing integrated energy efficient building systems through researching the relationships between productivity and energy use, developing integrated large and small HVAC system designs, developing energy efficient commercial building ceiling systems, developing integrated residential ducting and air flow systems, and assessing exterior lighting energy use and potential for energy savings.

Industrial/Agricultural/Water End-Use Energy Efficiency Issues, Successes and Outlooks

The Process Energy Program has identified

the following issues, which are specific to the industrial, agriculture, and water program sectors and also cut across these sectors.

- Lower the cost of electricity needed for water delivery, application and/or processing for industry, agriculture, and for municipal water and wastewater treatment systems.
- Develop more energy efficient process management systems, equipment diagnostic systems, and electrotechnologies.
- Develop electrotechnologies that reduce the cost of disposing industrial wastes.
- Reduce production costs by improving on-site power quality and reliability technologies.
- Reduce industrial and agricultural costs by improving electric load management and metering technologies.

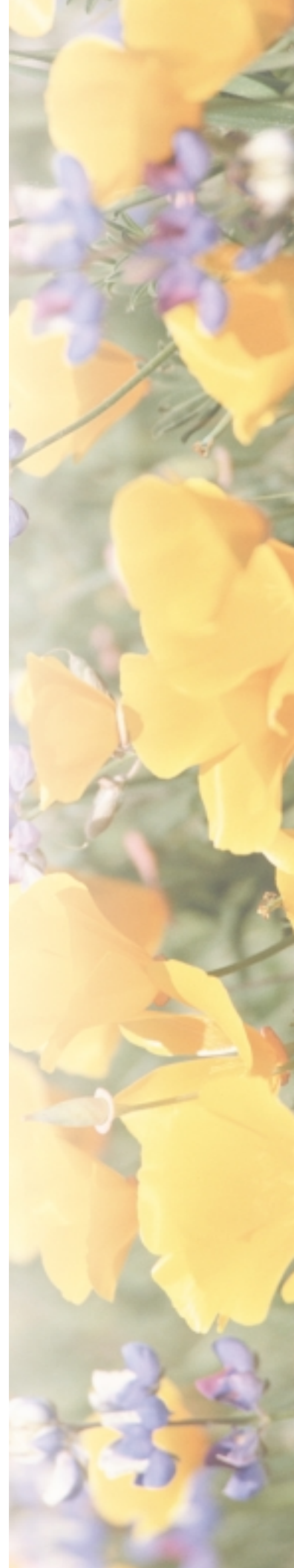
The resolution of these issues will enhance the competitiveness of California industries.

Examples of public benefits realized in 1999:

In agriculture, PIER has funded work both in conjunction with EPRI and as a member of EPRI. PIER-funded work has successfully tested the use of ozone-treated water as a disinfectant in poultry meat production (ozone is generated using electricity). The initial results indicate that this technology will allow water recycling in poultry production as well as significantly reduce wastewater treatment costs.

PIER funds have helped develop energy efficient water management practices for California's vineyards. California State University at Fresno has disseminated the results of this research through a report on water management in vineyards.

In the industrial sector, PIER has funded development of a low air volume fume hood for high technology efforts. During 1999, Lawrence Berkeley National Laboratory (LBNL) successfully tested the hood, which reduces the volume of consumed air by over





50 percent. The fume hood not only saves energy but also contains contaminants better than traditional hoods do. LBNL has found a commercial partner for commercial testing and eventual production.

Examples of public benefits anticipated in 2000:

In 2000, the Process Energy Program will receive results of its tailored collaboration with EPRI's Water/Wastewater Target. EPRI is developing an analysis and plan for addressing industrial water use research. The analysis will include a review of existing technologies that can reduce electricity and water consumption and determine what further research can help fill in gaps. The result will be a list of research projects that could help California industry reduce energy and water use. The list will focus on the California industries that use the most water and electricity.

Research contractors will provide final reports on testing oxidation of MTBE through pulsed ultra-violet irradiation, combined pulsed ultraviolet and hydrogen peroxide injection, ozone and hydrogen peroxide injection, and ozone and PEROXONE injection. The final reports will also evaluate the impact of using pulsed ultra-violet irradiation to destroy perchlorate, bromate, and n-nitrosodimethylamine (NDMA). The contractors will also provide final reports on the effectiveness of pulsed ultraviolet irradiation in inactivating heterotrophic bacteria, coliphage and phi 6 bacteriophage, *Giardia*, and *Cryptosporidium*.

Renewable Energy Issues, Successes and Outlooks

The emergence of a deregulated electricity marketplace and significantly decreased costs for natural gas-fired combined cycle technology have left California's renewable energy industry struggling to compete. Presently, five major issues face California's renewable energy industry:

- Although renewable energy technologies have a wide variety of capital and operating costs, most renewables are not currently competitive in a deregulated electricity market.
- With some exceptions, such as hydro-electric systems, renewable electricity generation systems lack the same degree of reliability and dispatchability as existing fossil-fueled generation systems. These drawbacks greatly impede the ability of renewables to sell power at the premium prices that would help increase their competitiveness.
- Based on the favorable economics associated with displacing retail electricity rates, California's distributed energy marketplace is an economically attractive market for renewables. California has abundant and widely dispersed supplies of renewable energy resources, making renewable energy technologies excellent candidates for distributed energy generation. However, concerns regarding possible impacts of renewable energy facilities on the safety and power quality of the electricity system have limited their acceptance as distributed generation resources.
- Renewable energy systems can provide a variety of non-energy benefits to California. However, to be competitive in a deregulated electricity marketplace, renewable energy providers must find ways to obtain economic rewards for providing non-energy benefits.
- To maintain their image as a cleaner energy alternative, renewable energy systems must either demonstrate emissions that are as low as those from competing natural gas-fired systems or they must better resolve California's critical environmental issues.

PIER RD&D efforts in the renewable energy area have focused on working collaboratively

with private industry, the national labs, not-for-profit research entities, and academic institutions to solve the major issues facing California's renewables. Four renewable energy projects were funded in PIER's first solicitation, the Transition Solicitation.

One of the more successful Transition projects was the Edison Technologies Solutions (ETS) Photovoltaics project. The purpose of this \$1 million project was to help develop standardized photovoltaic (PV) systems as a clean distributed energy option for California, while simultaneously avoiding the cost of upgrading or building expensive new distribution lines at the local level. Among the PV systems developed and installed under the ETS project was a 115 kilowatt (kW) facility at the Monterey Hills School in South Pasadena, a 110 kW facility at the Huntington Library in San Marino, and the PV-powered Ferris wheel at the Santa Monica Pier. ETS estimated that this project saved California ratepayers over \$1.5 million in new distribution lines.

Twelve renewable energy projects funded under PIER's First and Second General Solicitations have been making steady progress toward resolving major issues facing California's renewable energy industry. Major outcomes anticipated for the year 2000 from these efforts include:

In the area of making renewables more cost competitive:

- Installation and testing of a prototype next generation wind turbine by the Wind Turbine Company capable of generating electricity in the near term at \$0.035 per kilowatt-hour, and by 2002 at \$0.025 per kilowatt-hour. In conjunction with lower cost energy storage and wind forecasting capabilities, we expect wind technology will be fully competitive in California's deregulated electricity marketplace by 2002.
- The design, fabrication, and field testing of an extended induction logging tool by ElectroMagnetic Instruments, Inc. that will

significantly help in managing existing geothermal reservoirs and reduce the costs associated with geothermal exploration and extraction. Presently, exploration accounts for nearly 40 percent of the cost of harnessing geothermal energy.

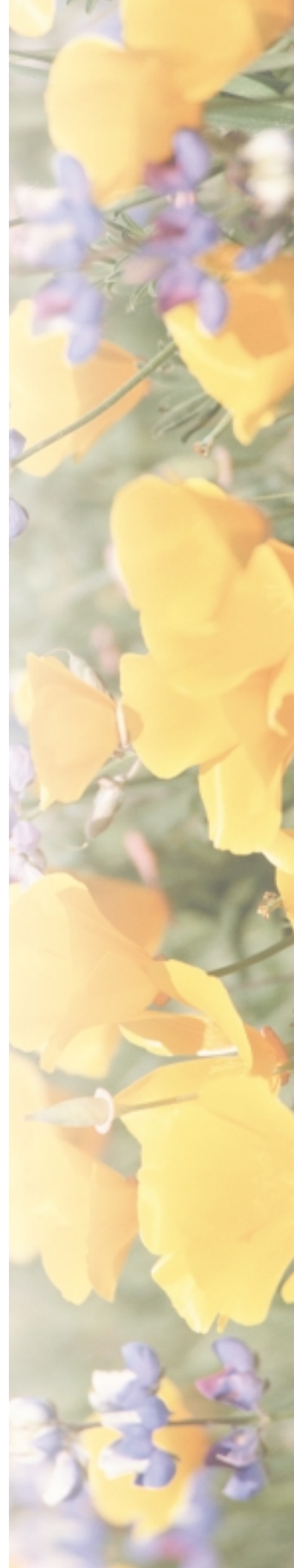
- Engineering designs and system analysis for what may be California's first co-located biomass power plant and ethanol manufacturing facility at the Collins Pine site will be completed by mid to late 2000. The colocated approach may not only help California's remaining 530 megawatts of biomass power be cost competitive, but it will also help in meeting the Governor's initiative to develop a California based alternative to MTBE. We expect the first of at least four co-located facilities to be built in California by 2001.

In the area of increasing the reliability and dispatchability of renewable energy systems:

- The Gas Research Institute will complete field tests of low NOx natural gas co-firing systems at two existing biomass power plants. Co-firing provides existing biomass power plants with much faster ramp up times and the capability to obtain peak demand revenues, thereby enabling biomass power plants to provide part of their electricity on a dispatchable basis. In addition, the low NOx design will reduce NOx emissions from biomass power plants by at least 20 percent.
- PowerWheel will complete field testing of its low head, low impact hydroelectric system. The PowerWheel system can potentially be installed in thousands of irrigation canals located in California, thereby increasing renewables use as a distributed electricity resource. Field tests will focus on the costs and reliability of the low head hydroelectric system.

In the area of power quality and safety:

- The Sacramento Municipal Utility District (SMUD) will establish a test center for





evaluating the reliability, safety, and efficiency of power conditioning units (PCUs) used for connecting distributed energy resources to California's grid. In 2000, testing will include demonstration of islanding detection schemes of multiple PCUs, an area of major interest to utilities facing the growth of distributed generation systems.

- By the end of 2000, Utility Power Group is expected to complete development and field testing of an advanced rooftop photovoltaic, power conditioning, and battery storage system. The system will reduce the installed cost of grid connected PV systems by over 30 percent and increase reliability of the systems by a factor of five.

In the area of obtaining economic rewards for providing non-energy benefits:

- PowerLight Corporation will complete developing advanced automated manufacturing methods to reduce component and system manufacturing costs by over 20 percent. PowerLight uses a novel approach to resolving the economic barriers facing photovoltaic (PV) systems. Because the PowerGuard® system extends the life of commercial roofing, the PV portion of the system can be offered at essentially no extra cost to customers.

In the area of increasing environmental benefits:

- GE Energy and Environmental Research Corporation will complete design of a full-scale gasification system capable of using low quality biomass residues at California biomass power plants. To date, less than 15 percent of California's biomass residues are used in biomass power plants. While some residues are disked back into the earth, many are burned openly in the field creating air pollution problems or are sent to landfills for disposal. If successful, this new technology could enable use of many of these lower quality residues as lower

cost fuels for California biomass power plants.

Environmentally-Preferred Advanced Generation Issues, Successes and Outlooks

In a restructured market, distributed generation will reduce the cost of electricity, improve local power quality, increase electrical system reliability, and postpone or eliminate the need for new or expanded transmission and distribution facilities. To facilitate widespread use of distributed generation and to improve California's air quality, new environmentally-preferred advanced generation (EPAG) technologies, simplified electronic controls, and reliable emission reduction technologies are needed. The following major issues limit the deployment of EPAG technologies as distributed generation in California's electricity marketplace:

- New efficient, cost-effective, and flexible small and intermediate scale environmentally-preferred power generators are needed that can be successfully used as distributed generation resources in California.
- Simple, cost-effective interconnection control systems with communication capability are needed that will allow EPAG technologies to be successfully used as distributed generation resources in California.
- Most current EPAG technology development efforts result in only small incremental improvements in generation efficiency. Innovative or revolutionary approaches are needed to achieve significant improvements in efficiency.
- New cost-effective pollution control technologies for all sizes of generators are needed that reduce the adverse health and environmental impacts associated with power plant emissions.

Examples of public benefits realized in 1999:

Fuel Cell Development and Demonstration

To date, the Commission has awarded 14 EPAG contracts that have addressed or are addressing the issues listed above. A Transition Solicitation project, conducted by San Diego Gas & Electric Company, successfully operated a 75 kW integrated pressurized molten carbonate fuel cell (MCFC) power plant technology at the Marine Corps Air Station Miramar in San Diego. This technology will have distributed generation applications with greatly reduced air emissions and higher efficiency than existing state of the art distributed generation technologies.

Performance operations of this improved design, associated systems, and components continued for about 3,300 hours and generated 250 MWh of electricity, consistently exceeding its rating throughout the test period. Nitrogen oxide emissions were below 0.4 parts per million (ppm). The test verified significant environmental benefits of the MCFC technology and proved the viability, reliability, and durability of the MCFC technology. The system performance exceeded expectations and provided valuable design and operating data and information that will be used in the next generation, 250 kW pre-commercial unit (over 65 percent efficient, NOx below 0.4 ppm and cost under \$1000/kW), to be tested in the year 2000.

Distributed Resources Demonstration

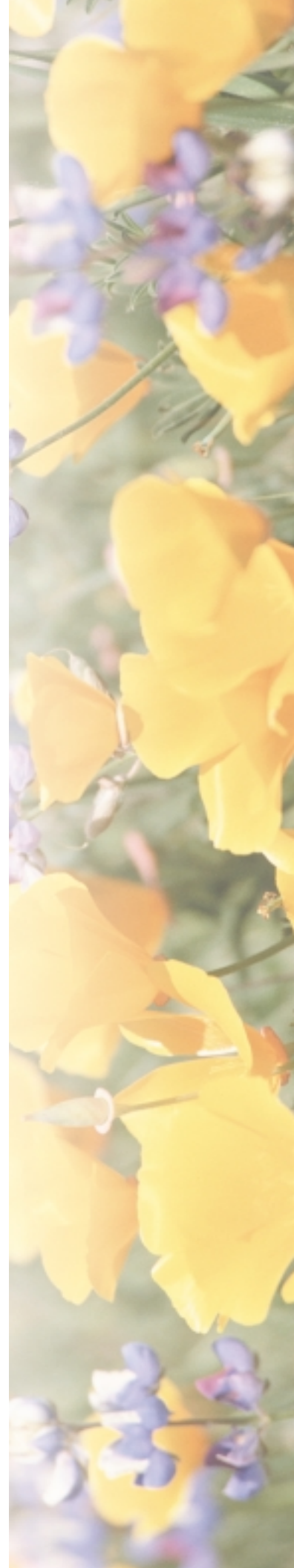
A second Transition Solicitation project conducted by San Diego Gas & Electric Company successfully demonstrated and evaluated a solid-state interconnection system for distributed energy technologies. These solid-state interconnection devices, which use power electronics to monitor and protect the generation system, were shown to be less expensive and just as reliable as traditional utility scale devices.

This demonstration exceeded all performance expectations for power quality, harmonics, transients during synchronization with the grid, operational flexibility, and remote communications. The demonstration showed how the utility grid could now easily accommodate new smaller sized distributed generation technologies to enhance electric system reliability and increase overall flexibility of the grid. Based on this demonstration, a distributed energy resource supplier is planning on integrating this device as part of their commercial packaged generation system.

Examples of public benefits anticipated in 2000:

One of the major objectives of the EPAG Program Area is to greatly reduce, or eliminate, the formation of emissions from power plants rather than developing post-combustion clean-up technologies. A project with Catalytica Combustion Systems of Mountain View will demonstrate a low cost means of reaching NOx emissions below three parts per million during 2000. Catalytica will complete an 8000-hour durability test of their first gas turbine combustor, fitted to a 1.5 MW Kawasaki turbine, in grid connected service. In addition, Solar Turbines of San Diego will complete design and testing of a Catalytica equipped combustor for up to three of their turbine engine products in 2000.

A project with Southern California Edison will develop and demonstrate a 250 kW Pressurized Solid Oxide Fuel Cell – Micro-Turbine Generator Hybrid System in collaboration with Siemens-Westinghouse. Siemens-Westinghouse will complete system development and integration by March 2000. The integrated system will be tested for the first time at the National Fuel Cell Research Center at the University of California at Irvine. Testing will be completed by late 2000 to confirm the system's benefits such as high efficiency (initially over 60 percent), low NOx emissions (under 1 parts per million),





and low electricity costs. The test results will become the basis for an over 75 percent efficient 1MW size scale-up design and development of this system for market entry between 2003 and 2005.

Energy-Related Environmental Research Issues, Successes and Outlooks

Environmental impacts occur whenever energy is extracted, collected, transported, converted, or utilized. The Environmental Research Program Area focuses its project funding on better understanding and addressing the effects of these processes. Specifically, RD&D is needed to:

- Improve air quality despite continuing urban growth
- Develop alternative water supplies to address projected regional shortages
- Reduce the adverse effects of energy systems on plant and animal species and their habitat
- Better understand the regional effects of global climate change

Example of public benefits realized in 1999:

One promising series of projects funded under the first general PIER solicitation features developing electrotechnologies that can produce new supplies of reliable and affordable drinking water, reduce electricity used to deliver and treat that water, and reduce the environmental problems created by current treatment and transport processes. Six innovative electrotechnology-based water treatment processes are being evaluated by a consortium consisting of the Metropolitan Water District of Southern California, the Orange County Water District, and the Electric Power Research Institute.

This project addresses California's increasingly important water supply and treatment issues and supports the objective of reducing environmental and public health costs/risks by developing technology to eliminate conventional, chemically intensive water

treatment techniques. It will also help avoid transfers of water from environmentally sensitive areas in Northern California to Southern California. State and local economies will also benefit by reducing electricity use and the costs of transporting water over long distances.

By the year 2020, it is estimated that the annual water demand in Southern California will exceed supply by 1.4 million-acre feet per year. In the Orange County groundwater basin alone there will be an additional 150,000 acre-feet of water needed annually by 2020. Based on the RD&D results from this project, the Orange County Water District has decided to build a \$275 million treatment facility which will recharge the groundwater basin with reclaimed water to supply nearly two-thirds of pending demand. The filtration methods being researched will also reduce groundwater salinity by more than 13 percent, which will reduce costs associated with damage caused by salinity.

Example of public benefits anticipated in 2000:

Global climate change, which results from the release of carbon dioxide, methane, and other gases to the atmosphere, has the potential to affect all segments of society in California. PIER funds will augment an ongoing global climate change study to allow a more in-depth analysis of the potential impacts to California's ecosystems, agriculture, hydroelectric and water resources, energy consumption, and other factors affected by climate. This project should provide the following benefits:

- Provide technical information necessary to debate global climate issues and develop energy policy options
- Deliver results from analyses that can be used to develop state-level policy options for global climate change concerns
- Identify future areas of research based on their level of importance to California

- Disseminate this information to the broadest audience possible

Strategic Energy Research Issues, Successes and Outlooks

The Strategic Program Area seeks to develop critical infrastructure changes that allow electricity transactions to be made in a more effective, efficient, reliable, and environmentally acceptable manner. The infrastructure includes generation, transmission, distribution, control, and communications technologies from generation to end use, all functioning in an integrated fashion. The infrastructure also interconnects with other critical infrastructure such as telecommunications. The Strategic Energy Program focuses RD&D funding on these issues:

- Develop technologies to facilitate expanded use of distributed energy resources, including interconnection, inverters and other system controls, as well as predictive models
- Develop an improved communications infrastructure that facilitates decision making in real time, day-ahead market and longer term futures market
- Develop advanced energy storage technology to meet consumer needs for load leveling, power quality, ancillary services, and plain storage
- Develop technologies that enhance electrical system reliability in the event of natural disasters, such as earthquakes
- Develop technologies to maintain and enhance system reliability in the face of increasing traffic and congestion, while avoiding the environmental impacts associated with new transmission lines and corridors
- Cross cutting, long term, and innovative advancements of science and technology should be supported, despite unclear current application
- Develop advanced mathematical models that analyze and research market

structures within which electricity transactions occur

Examples of public benefits realized in 1999:

Electric System Seismic Safety and Reliability

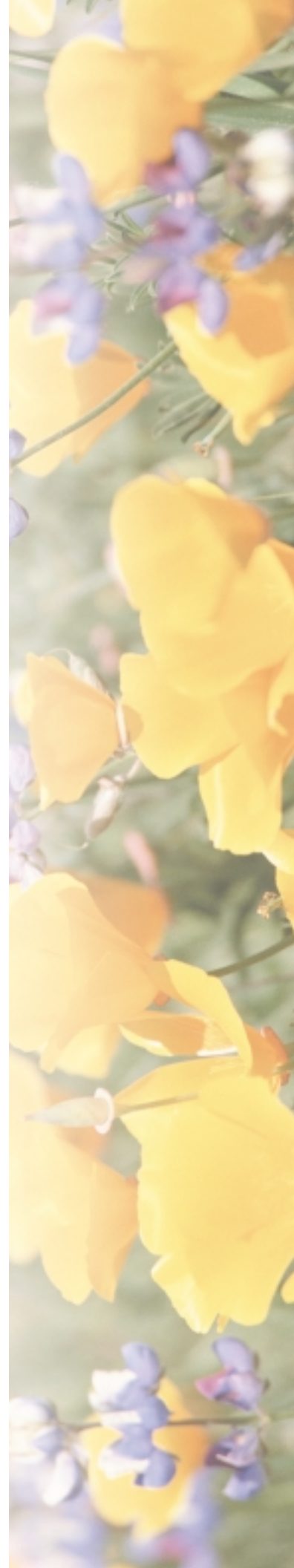
The purpose of this Transition Solicitation project is to support several major research efforts in the field of electric system seismic safety and reliability. This project improves the reliability of California's electricity by reducing the vulnerability of the electric transmission and distribution system to damage caused by a major earthquake, by maintaining power in an area affected by an earthquake, and by promoting the rapid recovery of electric service.

Research efforts ranged from the shake table testing of electric bushings and the collection of soil data at existing substations, to the development of a rapid response, strong ground shaking contour map program and related strong ground motion attenuation curves. Some of the early products have already been incorporated by a major California utility in their risk management practices.

Development of a Composite Reinforced Aluminum Conductor

The purpose of this project is to improve the reliability and capability of California's transmission and distribution system by developing a stronger and lighter conductor to replace these aging and overloaded power lines.

Specifically, this project will develop a composite reinforced aluminum conductor to replace conventional conductors made from aluminum wires wrapped over a core of steel strands (called aluminum conductor—steel reinforced conductors). Many miles of California's overhead electricity transmission lines have reached the end of their service lives or are being stressed beyond their design limits due to load growth and heavy power transfers across longer





distances. This technical development is very timely as the current age of transmission lines ranges from thirty to seventy years.

Examples of public benefits anticipated in 2000:

Looking forward to the year 2000, the Strategic Program will be implementing several programmatic contracts which extend the benefits of already completed work. The programmatic contracts include:

Electric System Reliability

The purpose of this intergovernmental agreement is to undertake a multi-year program of research and development to improve the reliability of and enhance access to the California electricity system under restructuring. This program supports the SB 90 mandate to include...“strategic energy research...including system reliability” and includes research in five broad areas:

- Real-time system management tools
- Distributed autonomous reasoning agents for distributed resources
- Demand responsiveness techniques
- Ancillary services market design
- Evolutionary roadmapping of research needs

The program aims to maintain overall system reliability at no more than “one-day-in-ten” loss of load probability, while enhancing access to the system for demand responsiveness, independent generators, and distributed resources. In addition, the program aims to provide critical input to the design of the ancillary services market.

Electric System Seismic Safety and Reliability

The purpose of this contract is to fund and support research on earthquake hazards and

vulnerabilities. Research and development will support the rapid application of methods and technologies for reducing earthquake vulnerability, improving the restoration of electric service after earthquakes, and improving overall public safety. Of significant note is the development, for emergency response personnel, of a real time strong ground shaking mapping system. In addition, basic seismic science will be advanced and applied to improved seismic design standards. This program will also benefit from co-funded projects of mutual interest sponsored by CalTrans for freeway and bridge application.

D. Summary of 1999 PIER Awards listed by Funding Method and Administration

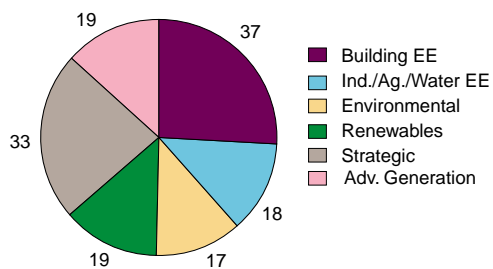
During 1999, the Commission used three different methods to select and fund public interest RD&D projects under the PIER Program. These methods are competitive awards, sole-source contracts, and interagency/intergovernmental agreements. During 1999, the Commission approved public interest energy research awards totaling approximately \$46 million through the following funding methods:

- Twenty-one competitive awards totaling \$17.2 million².
- Four sole-source contracts totaling \$16.7 million.
- Four interagency/intergovernmental agreements totaling \$12 million.

On average, every PIER dollar is being matched by \$4.89 from PIER’s research partners. The \$46 million in PIER awards will be matched with approximately \$225 million in other cash and in-kind matching funds, thus providing approximately \$271 million in total funding for these public interest energy research projects.

² Eighteen of these awards were made through the Energy Innovations Small Grants Program which is funded by a \$5 million interagency agreement awarded by the Commission in 1998 to the California State University Institute.

Number of Projects by PIER Program Area* – 1998-1999



* Does not include three 1998 funded PIER projects that were cancelled.

PIER's 1999 awards are administered by nine program leads. There is a program lead for each of the six PIER Program Areas. The other three leads administer awards respectively for the Energy Innovations Small Grants Program, the Electric Power Research Institute award, and the Gas Research Institute award. The \$46 million in 1999 PIER awards breaks down administratively into the following amounts:

- Nine awards administered by four of the six PIER Program Area leads total \$33.9 million
- Eighteen Energy Innovations Small Grants Program awards total \$1.3 million³
- One Electric Power Research Institute award totals \$11.8 million
- One Gas Research Institute award totals \$365,100

The following summaries of the 1999 PIER Program funding awards are grouped according to the PIER administrative area that manages the awards.

1. Funding Research through PIER Program Areas

During 1999, the Commission approved public interest energy research awards totaling \$33.9 million directly through the PIER Program Areas⁴. The funding methods include one competitive solicitation, two sole source awards, and four interagency/intergovernmental agreements. A second competitive solicitation was released in 1999 and awards will be made early in 2000.

Appendix A provides a complete compendium and description of all projects funded in 1999.

Residential and Commercial Buildings End-Use Energy Efficiency Program Area

On July 13, 1999, the Residential and Commercial Buildings End-Use Energy Efficiency Program Area released a programmatic solicitation for funding approximately three separate programmatic contracts. Through this programmatic solicitation, the Commission seeks to encourage collaboration between diverse program elements where such collaboration will more effectively and efficiently address technical and market goals of the PIER Program. Three awards were approved from this solicitation at the December 1, 1999 Business Meeting totaling \$17.3 million. The \$17.3 million will be allocated over three years in the following amounts: \$5.7 million for 2000, \$5.8 million for 2001, and \$5.8 million for 2002. These three projects were previously described in the section entitled:

³ These 1999 grants are being funded by a \$5 million interagency agreement awarded by the Commission in 1998 to the California State University Institute.

⁴ This total does not include awards made under the management of PIER's three other administrative leads: the lead for the Energy Innovations Small Grants Program, the lead for the Electric Power Research Institute award, or the lead for the Gas Research Institute award. 1999 PIER awards administered by these three leads also provide benefits under the six PIER Program Areas. The 1999 PIER awards administered by these three leads are discussed under their respective headings in this report.



Buildings End-Use Energy Efficiency Issues, Successes and Outlooks.

During the third quarter of 1999, the Commission approved expending \$60,000 for a two-year interagency collaborative research funding agreement with the Center for the Built Environment (Center). The Commission's research funding leverages over sixteen dollars for every one dollar of Commission funding resulting in approximately \$1 million in matching funds from other Center research partners. This collaborative research funding will enable the Commission to help steer the direction of research in this area and coordinate with other PIER-funded research, thereby maximizing the value to the PIER Program.

The Center is an industry/university/public cooperative research center founded by the University of California, the National Science Foundation, and industry partners. The Center focuses on buildings-related energy research that seeks to improve building design and operation and develop new technology. In addition, the Center seeks to better understand the human aspects of building energy use such as human response to lighting conditions, ventilation, and other factors affecting productivity and comfort.

Industrial/Agricultural/Water End-Use Energy Efficiency (Process Energy)

The Commission approved an 18-month, \$1.8 million interagency agreement with the University of California, Davis (UC Davis). This agreement will fund research to improve energy efficiency in the agricultural industry. UC Davis prepared this RD&D proposal in association with the United States Department of Agriculture, the University of California (Riverside), Utility Technology Associates, the Electric Power Research Institute, and Southern California Edison. These consortium members are providing \$2.1 million in matching funds.

Public benefits include potential energy savings of 2.4 billion kWh per year, safer and healthier work conditions for farm workers by eliminating toxic methyl bromide usage by 2005, and improved competitiveness of California's agriculture industry by producing safer and more affordable food.

Energy-Related Environmental Research

In June 1999, the Commission approved a \$3 million interagency agreement with the California Air Resources Board to conduct the Central California Ozone Study (CCOS). The area of study for this project is bounded by the Pacific Ocean to the west, the Sierra Nevada to the east, the end of the Sacramento Valley to the north, and the Mojave Desert to the south. This study will develop a better understanding of how thermal power plant plumes contribute to regional air quality problems in Central California. Specifically, the study will provide data and methods needed to assure the proper treatment of these plumes: 1) in models used to develop air quality management plans (AQMPs) and; 2) in assessing regional impacts of power plants licensed by the Commission.

A major objective is the development of workable inter-basin/inter-pollutant offset trading rules for the Central California region. Historically, the absence of such rules has prevented or delayed licensing of new power plants because local air districts have been reluctant to allow this type of offset trading without extensive site-specific atmospheric modeling. This study could significantly reduce regulatory uncertainty.

Other funding partners include the Bay Area Air Quality Management District, the Sacramento Metropolitan Air Quality Management District, the San Joaquin Valley Unified Air Pollution Control District, and other local air districts. The Commission's contribution leverages approximately \$9 million for the ozone study and another \$28 million for a complementary particulate study.

Strategic Energy Research

In April 1999, the Commission approved a \$100,000 award to co-fund a project to analyze the power quality impacts of large single-phase residential loads, such as electric vehicle chargers, computer equipment, appliances, and HVAC to residential distribution systems. The Commission's research partner in this project, Georgia Technology Research Corporation, is contributing \$95,000 in match funding.

In November 1999, the Commission approved a \$4.5 million sole-source contract to PG&E and U.C. Berkeley's Pacific Earthquake Engineering Research Center to conduct seismic research in several critical electric system research areas.

The work will be performed by researchers at several universities under the overall program oversight of PG&E, the Center, and the Commission. These funds will be expended over a three-year period and will be matched with approximately \$3.7 million from CalTrans and additional funding from the U.S. Geological Survey and the Federal Emergency Management Agency.

This project will improve the scientific knowledge of earthquake risks and develop tools to increase the ability of California's electric system to deliver critical services in the event of seismic events. It will also provide important information to emergency response personnel for planning for and responding to earthquake emergencies.

In December 1999, the Commission approved a \$7.2 million intergovernmental agreement to support a three year research program conducted by Lawrence Berkeley National Lab on behalf of the Consortia for Electric Reliability Technology Solutions. This award leverages \$11.8 million over three years.

The goal of this project is to maintain and enhance electric system reliability and improve access to the benefits of electric

restructuring. The project includes participation by the California Independent System Operator and the Power Exchange. The program will develop improved real-time system monitoring and improve control and communication technologies. In addition, improved integration of distributed resources and demand bidding will help ensure system-wide reliability as early as the summer of 2000. Finally, the program will develop advanced approaches to bidding for ancillary services, such as spinning reserve and voltage support. This latter feature will lower ratepayer costs for maintaining system reliability.

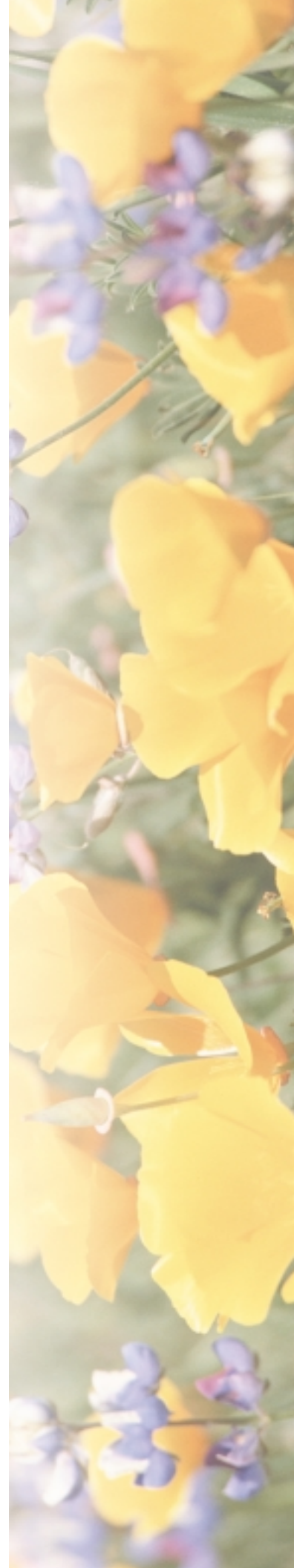
Renewable Energy Technologies Solicitation

In November 1999, the Renewable Energy Technologies Program Area released a \$1.3 million competitive negotiation solicitation for small-scale/modular distributed biomass power projects. Notice of Awards will be made in early 2000.

2. Funding Projects through the Energy Innovations Small Grants Program

The Energy Innovations Small Grant Program was created to meet three needs for the Commission's overall PIER effort:

1. Provide research support for innovative ideas not necessarily covered in the targeted PIER program area research plans.
2. Provide a user-friendly application process to groups that are affected by high transaction costs associated with the Commission's standard competitive bid processes. These groups are small businesses, individuals, academics, and small non-profits.
3. Provide a PIER funding mechanism for concept feasibility research and development. The "mainstream" PIER research efforts require that feasibility has already been established.





In addition, the Commission wanted to design a program with minimal demand on scarce staff resources. To accomplish this, the Commission approved a two year, \$5 million interagency agreement in 1998 with the California State University Institute to administer the Energy Innovations Small Grants program. The Institute developed a simplified funding application process to identify and recommend worthy “proof of concept” projects to the Commission. The Commission, in turn, participates in the project review process and maintains final authority to approve any projects that are recommended by the administrator.

In 1999, the Commission completed two rounds of solicitations for the Energy Innovations Small Grants Program. These solicitations resulted in 143 proposals. In 1999, the Commission awarded \$1.3 million to the 18 most promising proposals⁵. Awards were made in four of the six PIER Program Areas. A third solicitation released in 1999 resulted in 70 additional proposals that were evaluated and scored. The RD&D Committee intends to recommend funding for eleven proposals from this third solicitation in early 2000.

Tables 1 and 2 show how Energy Innovations Small Grant Program awards are distributed among the six PIER Program Areas and by applicant type⁶.

3. Supporting Projects through Collaborative Research Funding with the Electric Power Research Institute

The partnership with the Electric Power Research Institute (EPRI) enables the Commission to participate in and build on pre-existing collaborative relationships and

Table 1: Energy Innovations Small Grant Program Awards Analyzed by Program Area

(Rounds One through Three)

Program Area	Total	Percent of all Awards
Advanced Generation	\$ 748,930	34.5
Buildings	\$ 599,344	27.6
Renewable Energy	\$ 524,684	24.1
Industrial/Ag./Water	\$ 299,977	13.8
Environmental Research	\$ 0	0
Strategic Research	\$ 0	0
Grand Total	\$ 2,172,935	100.0

Table 2: Energy Innovations Small Grant Program Awards Analyzed by Applicant Type

(Rounds One through Three)

Applicant Type	Total	Percent of all Awards
Individuals	\$ 74,790	4.0
Small Businesses	\$ 1,198,266	55.0
Academic	\$ 899,699	41.0
Small Non-Profits	\$ 0	0
Grand Total	\$ 2,172,935	100.0

to continue important public interest energy and environmental research. In 1998, the Commission approved an initial one year \$1.5 million collaboration with EPRI, focused on funding collaborative research in seven key areas for California, (e.g. food processing, distributed generation, and grid system reliability). In 1999, the Commission unanimously extended the partnership through 2000, augmenting the funding with \$11.8 million, to include twenty additional research areas. (See Appendix A for a listing of PIER-funded EPRI research projects.) The Commission’s collaborative research funding leverages thirteen dollars for every one dollar of Commission funding resulting in \$152.8 million in matching funds from other EPRI research partners.

⁵ These 1999 grants are being funded by a \$5 million interagency agreement awarded by the Commission in 1998 to the California State University Institute.

⁶ Includes eleven grants from Solicitation Round Three recommended for funding by RD&D Committee, to be considered at the January 26, 2000 business meeting.

EPRI is a public purpose, nonprofit 501(c)(3) California corporation that was established in 1973 as a center for public interest energy and environmental research. Funding partners include municipal and investor owned utilities, government agencies, and federally chartered corporations. These entities represent approximately 90 percent of the electricity sold in the United States. Over the past twenty-seven years, EPRI funding partners have invested \$7 billion in this preeminent research organization and received over \$63 billion in benefits. EPRI has responded to the dynamics of electricity restructuring by reorganizing itself through a comprehensive 'roadmap' that maintains important public interest research into the 21st Century.

Through the EPRI partnership, the Commission is able to tailor this collaborative research to meet California's needs at a lower cost and with greater efficiency. To achieve these results, Commission representatives:

- Participate in approving and directing research in each target through advisory groups made up of funding partners.
- Have access to product and service information from the technical experts within and related to EPRI and from other member organizations.
- Have access to analytical tools and databases used in research, demonstrations, case studies, publications, and on-line communication services via the EPRI Web site.
- Have the ability to design very specific projects within target areas that the Commission is particularly interested in. These projects are called 'tailored collaborations'.

Partnership fees for each target are based on the percentage of public benefit as analyzed by Commission staff, multiplied by ten percent of the target cost which is California's

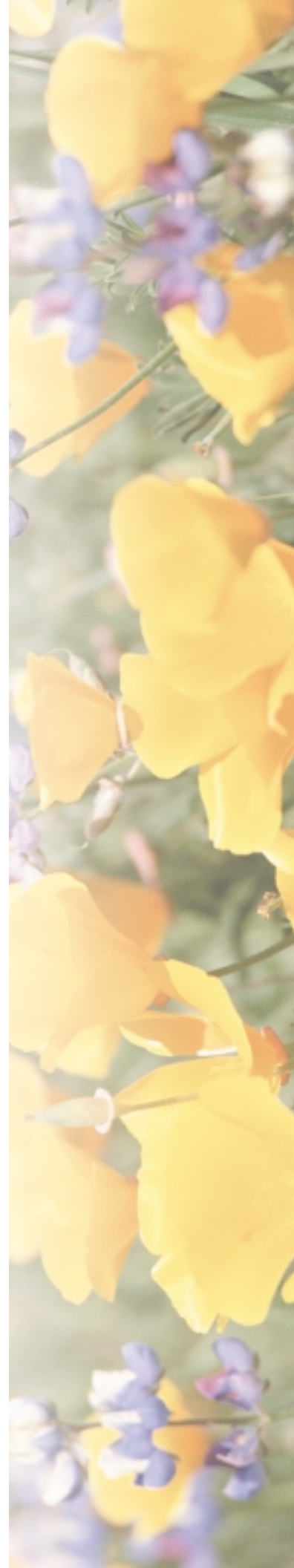
share of national energy usage. In addition to the 1998 products, the Commission will receive all 1999 and 2000 products through December 31, 2000. A list of all research target areas and their public benefits is found in Appendix A.


4. Supporting Projects through Collaborative Research Funding with the Gas Research Institute

The Gas Research Institute (GRI) is the national RD&D consortium for the U.S. natural gas industry, delivering over 400 products, processes, and techniques to the marketplace since its inception in 1976. The GRI has a unique approach to developing RD&D programs. The GRI does not perform the RD&D in-house, but funds the most qualified manufacturers, universities, RD&D firms, and others in order to perform the research needed to bring results to the marketplace. Many California companies are included in the mix of current and past GRI contractors and partners, including the Commission.

The GRI offers its research partners the flexibility to select from a comprehensive list of program areas. Research partners share the cost of conducting research in program areas so that an individual member's investment is leveraged substantially and the benefits far outweigh the dollar investment. Research performed by GRI over the years has had widespread applications in the energy market, providing benefits to both natural gas and electricity ratepayers.

In June 1999, the Commission approved (with the Legislature's concurrence) an 18-month sole source contract for extending collaborative research funding with GRI. The \$365,100 collaborative research funding supported five program areas including advanced fuel cells, distributed generation, industrial waste processing, high efficient industrial combustion, and commercial cooling/heating pump applications. The Commission's collaborative research funding





leverages \$7.3 million in matching funds from other GRI research partners.

The Commission believes that collaborative research funding in the five selected program areas will improve the energy cost/value, the reliability and quality, and the public health costs/risks of California's electricity. (Specific project benefits are listed in Appendix A.) Participation in the advisory structure for selecting research targets and having access to research results enables staff to improve research products and enhance interactions with other market sector customers.

E. Meeting the Reporting Mandates of the 1999/00 Budget Act

This document meets the reporting mandates of the 1999/00 Budget Act (Item 3360-001-0381) by providing two required project listings in Appendix A. The first requirement is an itemized list for projects awarded funding in 1999 broken down by program area—including a project description, grant amount, and proposed outcomes. The second requirement is an itemized list for projects awarded funding in 1998 broken down by program area—including a project description, grant amount, and actual outcomes. Both of these required lists are found in Appendix A.

F. PIER Program Administration **1. Improving PIER Program Efficiency**

An important objective in the Commission's RD&D Strategic Plan is to ensure that the PIER Program is administered in an efficient and effective manner.

Before the PIER Program was developed, four line divisions within the Commission managed individual programs wholly within each division, and relied on the fifth division, Administrative Services, to provide support for contracts, grants, fiscal accounting and the like. Given that the program areas outlined in the RD&D Strategic Plan cut across all of the divisions at the Commission, a new

organization and reporting structure was needed.

Consequently, in 1998, interdivisional teams were created to address issues and responsibilities in each of the six PIER Program planning areas. In addition, the interdivisional teams were expanded to include legal and contracting experts, and the primary responsibility for certain program areas was shifted to the division with the most expertise. This new administrative structure is dynamic and will evolve along with other aspects of the program.

To improve the PIER Program's efficiency, the Commission reviewed its RD&D contracting procedures to identify areas for improvement. As a result, the Commission implemented a two phased effort to reduce the time and cost of contracting in the PIER Program. Phase I resulted in a package of specific statutory amendments enacted in 1997, through SB 90, to provide for contracting flexibility. Phase II resulted in additional streamlining through changes to various internal contracting policies and procedures at the Commission.

The Commission now uses customized contract terms and conditions which recognize relevant differences among client groups including universities, utilities, small business, and large business. These customized terms and conditions have dramatically reduced the time and effort required for executing contracts. In addition, a simplified invoicing process has been developed and is being used with all PIER contracts. The requirements for extensive back-up information have been eliminated and replaced by an audit program conducted by the Administrative Services Division.

In 1999, the Commission adopted "competitive negotiations" regulations to allow the Commission to negotiate the details of competing proposals to improve the quality of proposals. The Commission

also adopted regulations in 1999 that detail criteria to award PIER contracts on a sole or single source basis.

2. The Independent Panel for PIER Evaluation

Public Resources Code Section 25620.9(a) required the Commission to designate an independent panel of experts by January 1, 1999, to conduct a comprehensive evaluation of the PIER Program. The Panel is required to submit its preliminary report to the Governor and the Legislature by March 31, 2000, and a final report (including additional findings and recommendations) is due by March 31, 2001.

In 1998, following extensive statewide and national contacts, the Commission designated nine individuals to serve on the Independent PIER Evaluation Panel. The Commission named three additional members to the panel during the first quarter of 1999. The panel held its first meeting in February 1999 and expects to report their principal findings in the preliminary report.

To provide independence from the Commission, the Panel is provided analytical support by RAND Corporation and administrative support by the California Council on Science and Technology.

3. Technology Transfer

The Commission is keenly aware that RD&D efforts may be of little value if the results are not effectively transferred into the market. In 1999, the Commission undertook several steps to ensure that the results of the PIER funded RD&D efforts are effectively transferred into the market.

In October of 1999, the Commission sponsored a major PIER conference, *Energy Innovations '99: Sharing the Benefits of California's Research Investment*. This first conference facilitated the exchange of relevant information and ideas among researchers, technology users, and other interested parties from throughout the State,

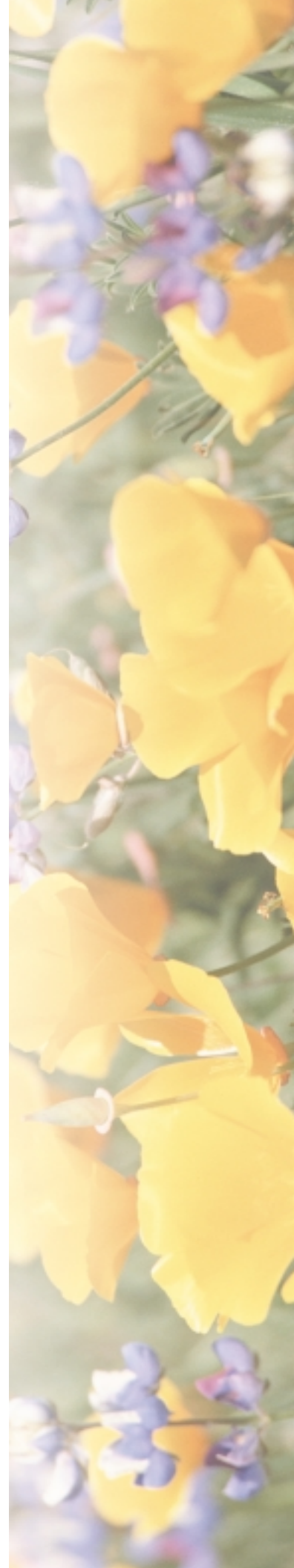
the nation, and the international community. The conference highlighted the PIER Program, which is the nation's most comprehensive ratepayer-funded public interest energy research program. Hundreds of energy innovators, from researchers to investors and consumers, attended the San Diego conference. Through the many presentations and discussions, attendees explored new opportunities for bringing PIER-funded energy innovations to the marketplace.

Attendees explored how to coordinate the PIER Program with other public interest energy programs and how to enhance the benefits of public interest energy research in California. This conference was designed to promote the entry of energy technology innovations into the marketplace as tangible benefits to California ratepayers. The conference proved to be an excellent forum for information exchange and will contribute to further innovations and benefits. Exhibits from more than two dozen PIER projects facilitated interaction with investors, manufacturers, and end-users as well as with other researchers. Two PIER Project participants based in San Diego offered site tours to attendees.

A PIER Program informational exhibit and a PIER Program brochure were developed to provide an overview of the PIER-funded programs. The exhibit and brochure helped transfer program information at the *Energy Innovations '99* conference and they will be used for technology transfer at future public forums.

4. Timely Reporting on the PIER Program

Public Resources Code Section 25620.5(h) requires the Commission to provide to the Legislature, on a quarterly basis, an "evaluation of the progress and a status of the [PIER Program's] implementation to date." In 1999, the Commission completed and filed each of these Quarterly Reports with the





Legislature in a timely manner. Public Resources Code Section 25620.8 also requires the Commission to report annually to the Legislature on the status of the PIER Program. This 1999 PIER Annual Report is being provided in a complete and timely manner.

5. 1999 Financial Statement for the PIER Program (January through December 1999)

1999 Income:

Payments from Utilities	\$61,840,469.96
Interest Earnings ⁷	\$2,693,156.89
Total Income	\$64,533,626.85

1999 Expenditures:

Program Funding ⁸	\$49,749,456.00
Program Administration ⁹	\$2,749,368.87
Total Expenditures	\$52,498,824.87

1999 Reserves:

Available for future allocations	\$12,034,801.98
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III. Future Program Directions

In 2000, the Commission intends to build on its successful first two years of the PIER Program and maximize the value of the program by:

- More sharply focusing future PIER funding awards on those areas of public interest energy research that are of the highest priority and greatest benefit to California's citizens;
- Increasing the "purchasing power" of available PIER funds by selectively entering into major co-funded RD&D efforts with the federal government, other states, and non-profit organizations;

- Evaluating the effectiveness of the "competitive negotiation" method to augment traditional project selection methods;
- Effectively using its authority to enter into PIER contracts on a sole or single source basis;
- Carefully and efficiently managing all existing PIER contracts to ensure that ratepayer funds are well spent and that maximum public value is obtained from these contracts; and
- Initiating steps to effectively transfer into the market the results of the various PIER-funded RD&D efforts.

Further details regarding each of these "future directions" are set forth below.

A. Focusing Future Funding Awards

In 1999, the Commission undertook a number of steps to identify the public interest energy research areas of highest priority and value to California's citizen. Among other things, the Commission completed a reliable "decision making analysis" procedure for identifying and prioritizing key energy research issues, completed interdivisional teams led by staff experts for each of the six key program areas, and completed the important process of selecting the main areas of focus for future PIER funding awards. In 2000, the Commission will more closely apply these planning results to refine the focus of PIER funding.

B. PIER Integrated Strategic Program Plan

Under the leadership of the RD&D Committee, the PIER Program teams have developed an integrated strategic plan. This

⁷ Interest earned in the State Pooled Money Investment Account in the State Treasury.

⁸ Amounts awarded by the Commission for PIER projects and programs.

⁹ Commission staffing and operating costs.

process involved intensive planning to develop a robust and balanced portfolio of innovative RD&D energy programs for future solicitations. The Strategic Plan integrates the six individual program plans developed by the PIER Program teams into a single comprehensive plan. This integrated plan will help ensure that maximum public benefit will result from PIER-funded RD&D.

As recommended by the Council and the Panel, the planning process has explicitly aligned proposed future PIER investments with legislative objectives and electric ratepayer needs, linking the RD&D to public interest criteria for consistent evaluation and ranking among the programs.

The Commission staff developed a comprehensive set of objectives and thirty-eight candidate RD&D programs designed to meet those objectives by working from an extensive list of ratepayer needs. The candidate programs were assessed for ratepayer benefits using sixteen evaluation criteria with explicit metrics, and the results of these evaluations were used to select proposed programs, not only for overall merit, but also for achieving balance across the public interest criteria. Portfolio robustness was achieved by selecting programs for value to ratepayers across a number of extreme, but possible, economic, environmental, regulatory, and market futures.

The Integrated Strategic Program Plan is currently documented in a draft report, and the planning process itself in workbooks which include the material developed at each step of the planning process. This latter type of documentation enables the staff to refine and reapply the planning process during future planning cycles.

In developing the Strategic Plan, Commission staff worked closely with the Commission's technical support contractor, Arthur D. Little, Inc. Arthur D. Little has extensive client experience in planning RD&D portfolios for both the public and private sectors.

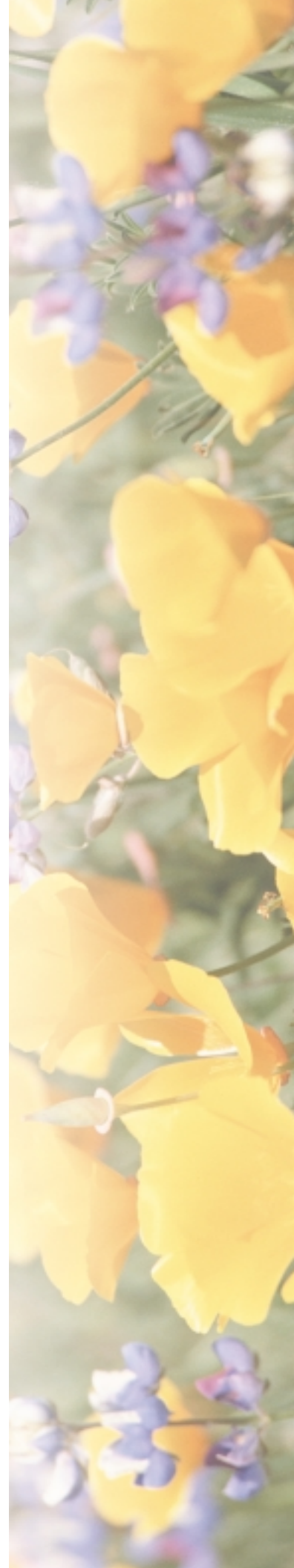
C. Coordinated Funding Efforts

In 1998, the Commission entered into an important Memorandum of Understanding (MOU) with the U.S. DOE. Among other things, this MOU committed the Commission and the DOE to a close working relationship intended to identify energy-related areas of mutual interest and high priority for future collaboration and co-funding. In 1999, activities to implement the MOU were extended to other states with energy RD&D programs, and a joint planning and budgeting process was developed and approved with the DOE. Work is also being done to develop standard terms and conditions for contracts between the Commission, the DOE, and the National Laboratories.

In addition, six near-term collaborative areas of work were established and teams from the states and the DOE were assigned to develop a collaborative plan and joint projects in each area. The six near-term areas of implementation for the MOU are biomass/biopower, distributed generation, fuel cells/microturbines, energy smart schools, small producer petroleum, and energy information. Commission staff lead the national teams in distributed generation and small producer petroleum technology. Collaborative plans have been developed during the past year in some of the near-term areas. Joint projects that expand California's purchasing power and benefits through PIER are expected to begin in the coming year.

D. Competitive Negotiations

In SB 90, the Commission was given the authority to engage in a "competitive negotiation" process when selecting projects for PIER funding awards. This process allows the Commission to "negotiate" the details of competing proposals, rather than be restricted to the "take or leave it" process of a traditional request for proposal. The Commission plans to use competitive negotiation solicitations for highly focused, targeted research projects where a small number of proposals are anticipated, so that





it is possible to devote sufficient time to negotiate with each applicant.

In 1999, the Commission adopted regulations for such “competitive negotiations,” which detail the process and criteria for conducting this new type of solicitation. The Commission also prepared its first PIER solicitation using this new method. In November, 1999, the Renewable Energy Technologies Program Area released a \$1.3 million competitive negotiation solicitation for small-scale/modular distributed biomass power projects. The effectiveness of this alternative solicitation mechanism for contracting will be evaluated and decisions about its future use will be made in 2000.

E. Sole/Single Source Contracts

In SB 90, the Commission was also given the authority to enter into PIER contracts on a sole or single source basis. A sole source contract is useful where the contractor offers a unique service that no one else can offer. SB 90 added other situations for PIER sole source contracts, such as where there is an urgent need for the service or the next phase of a multi-phased project. SB 90 describes a single source contract as a contract chosen without formal competition where there are two or more business entities capable of providing service to the Commission.

The Commission adopted regulations in 1999 that detail criteria to award PIER contracts on a sole or single source basis. The Commission also adopted procedures to assist staff in efficiently processing unsolicited proposals from potential contractors for a sole or single source contract. In 1999, the Commission entered into three contracts on a sole source basis, using the guidelines from the regulations and procedures.

F. Effective Management of Existing Contracts

In 1999, the Commission awarded approximately \$46 million in PIER funds to support energy RD&D projects. In 2000, the Commission will carefully monitor the progress of all active 1997, 1998, and 1999-awarded projects to ensure that funds are well spent, and that the public receives the maximum benefits from this portfolio of projects. Progress reports regarding these RD&D efforts will be provided to the Legislature through the 2000 PIER Quarterly Reports and the next PIER Annual Report.

G. PIER Audit Program

In 1999, the Commission developed and began implementing the PIER Audit Program. The focus of the program is to advise and assist PIER contractors in meeting the Commission’s administrative requirements while reducing the overall administrative reporting burden on PIER contractors and Commission staff. The PIER Audit Program ensures that expenditures by PIER contractors are appropriate and properly documented. The three-tiered program was designed to allow a combination of random and targeted engagements in the form of assessments, reviews, and audits. These engagements each differ in scope and level of review undertaken based on the objectives of each engagement. A contract with the California State Controller’s Office, Bureau of Audits, provides the necessary support and expertise for the PIER Audit Program.

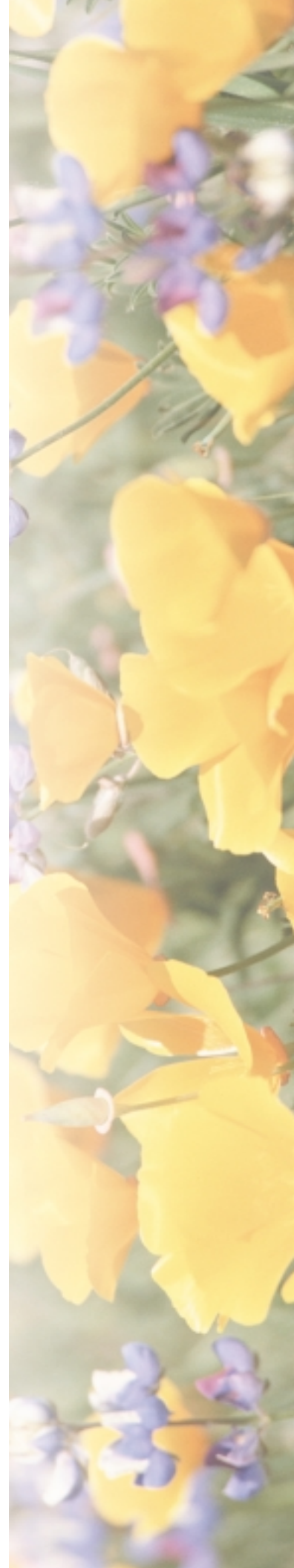
Since August 1999, nine on-site inspections have been completed, 24 percent of the active PIER contractors. The Commission plans to increase the number of inspections in 2000. The program’s goal is to inspect the records of approximately 50 percent of all active PIER contractors on an annual basis.

H. Technology Transfer

In 2000, the Commission will undertake additional steps to ensure that the results of the PIER funded RD&D efforts are effectively transferred into the market. The Commission will develop, maintain, and continuously update a new PIER-related Web site and data warehouse to keep the current status of projects and funding opportunities available to all. The Commission will also evaluate the effectiveness of the *Energy Innovations '99* conference and determine when future conferences will be scheduled.

IV. Conclusion

1999 was an exciting, challenging, and successful second year for the PIER Program. As described in this report, many public benefits are already being realized from PIER-funded research and many more are expected in 2000. The Commission fully anticipates that this program will continue to provide important public benefits in the years ahead, and will continue serving as a model for public interest energy research throughout the nation and the world.





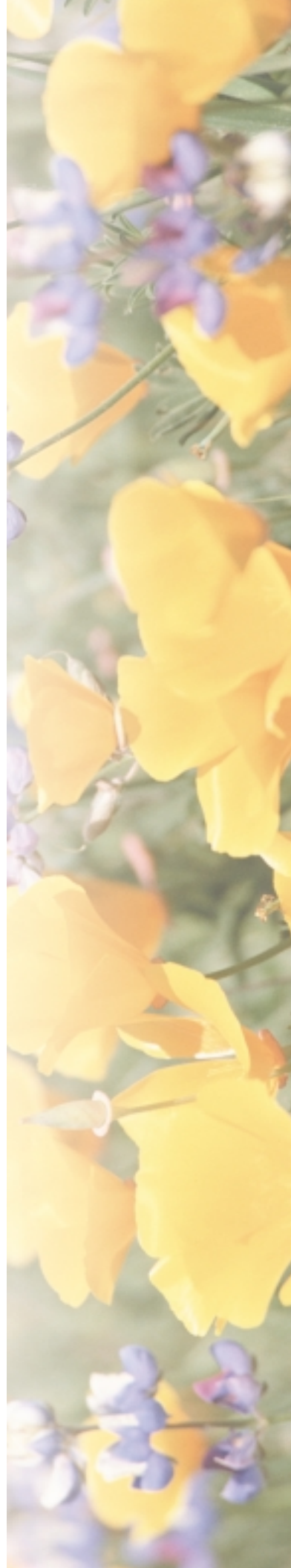
P I E R

Public Interest Energy Research

CALIFORNIA ENERGY COMMISSION

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- **APPENDIX C: Members of the PIER Policy Advisory Council**
- **APPENDIX D: Members of the Independent PIER Evaluation Panel**



**PIER Project Summaries
as Mandated in the
1999/2000 Budget Act**

APPENDIX A: PIER Project Summaries as Mandated in the 1999/2000 Budget Act

1999-AWARDED PIER PROJECTS

Projects Funded in 1999 through the PIER Program Areas

Residential and Commercial Buildings End-Use Energy Efficiency Program Area

- A-1** Center for the Built Environment (CBE)
- A-1** Energy Efficiency and Affordable Small Commercial and Residential Buildings Program
- A-2** High Performance Commercial Building Systems Program
- A-3** Integrated Energy Systems Productivity and Building Science Program

Industrial/Agriculture/Water End-Use Efficiency Program Area

- A-4** Energy Efficiency Agricultural Technologies

Energy-Related Environmental Research Program Area

- A-6** Central Valley Ozone Study

Strategic Energy Research Program Area

- A-6** Electric System Seismic Safety and Reliability
- A-7** Electric System Reliability Enhancements
- A-8** Secondary Distribution System Impacts of Resident EV Charging

Projects Funded in 1999 through the Energy Innovations Small Grants Program

- A-9** Electrosynthesis of Device Quality Semiconductor Films
- A-9** Ventilation Measurement and Control
- A-10** Control of On-Off Equipment in Buildings
- A-10** Process for Converting Sewage Sludge and Municipal Solid Wastes to Clean Fuels
- A-11** New Generation Thermoelectric Materials for Power Generation and Refrigeration
- A-11** Renewable Hydrogen Fuel Production by Microalgal Photosynthesis
- A-12** SunGuard: Roofing Tile for Natural Cooling
- A-12** Modeling Greenhouse Temperature for Energy Efficient Production
- A-12** A New Gas Turbine Engine Concept for Electricity Generation with Increased Efficiency and Power
- A-13** Development and Characterization of Improved Solid State Dye-Densitized Nanocrystalline Solar Cells
- A-13** Actively Controlled Jet Injection in Gas Turbine Engines
- A-14** Omni SmartPump
- A-14** Improved Operational Turndown of an Ultra-Low Emission Gas Turbine Combustor
- A-15** Low Cost Microchannel Reformer for Hydrogen Production from Natural Gas
- A-15** Feasibility of Solar Fired, Compressor Assisted Absorption Chillers
- A-15** Energy Shaver – A Thermal Energy Storage Device for Air Conditioners
- A-16** High Speed Light Activated On/Off Thyristor
- A-16** Power Quality and Energy Conservation through Power Factor Correction

Projects Funded in 1999 through Collaborative Research with the Electric Power Research Institute

- A-17** Target 1 Residential Heat Pump Technology
- A-18** Target 7 Commercial Heat Pump/Air Conditioning Technology
- A-20** Target 9 Commercial Building Thermal Storage
- A-20** Target 11 Commercial Building Lighting
- A-21** Target 18 Materials Fabrication
- A-22** Target 19 Materials Production
- A-23** Target 27 Electronics Industry
- A-24** Target 28 Airport Solutions
- A-25** Target 35 Customer Power Conditioning Solutions
- A-26** Target 38 Power Quality for Improved Industrial Operations
- A-28** Target 41 Opportunities in Networked Home Services
- A-29** Target 49 Power Markets and Risk Management
- A-30** Target 63.0 Emerging Distributed Resource Technologies; 63.1 IC Engine Development for DR Applications; 63.4 Fuel Cell Distributed Power Systems
- A-31** Target 66 Renewable Technology Options and Green Power
- A-32** Target 87.0 Hydropower Operations, Relicensing and Environmental Issues; 87.1 Environmental Issues Management
- A-34** Target 91 Air Toxics Health and Risk Assessment
- A-36** Target 97 Groundwater and Combustion By-Products Management
- A-37** Target 103 Fish Protection Issues (Clean Water Act, Section 316 A&B)
- A-37** Target 105 Facilities Water Management
- A-38** Target 107 Plant Multimedia Toxics Characterization (PISCES)

Projects Funded in 1999 through Collaborative Research with the Gas Research Institute

- A-40** Advanced Fuel Cells (#165)
- A-40** Distributed Generation (#733)
- A-41** Industrial Waste Processing (#825)
- A-41** High Efficiency Steam Generation (#1218)
- A-42** Commercial Cooling and Heating Pump Applications (#1417)

1998-AWARDED PIER PROJECTS

Projects Funded in 1998 through the PIER Program Areas

Residential and Commercial Buildings End-Use Energy Efficiency Program Area

- A-44** Evaluate Small Commercial Air Conditioning Units for Northern/Central California
- A-44** Improve the Cost Effectiveness of Building Commissioning Using New Techniques for Measurements, Verification and Analysis
- A-45** Improve the Cost Effectiveness of Building Control Systems Sensing and Data Collection
- A-45** Residential Thermal Distribution
- A-46** Commercial Thermal Distribution Systems
- A-47** Diagnostics for Building Commissioning and Operations
- A-48** Building Design Advisor
- A-49** Alternatives to Compressor Cooling

- A-50** High-Efficiency Lighting Torchieres
- A-51** CIEE Collaborative Program Planning and Management
- A-51** Energy Efficient Downlights for California Kitchens
- A-52** Increased Energy Efficiency of Refrigerators and Air Conditioners through Use of Advanced Power Electronics
- A-53** Development of an Advanced Indirect Evaporative Heat Exchanger Module
- A-53** Conceptual Design Energy Analysis Tool
- A-54** Alternatives to Compressor Cooling: Phase V
- A-54** A Tool for the Comprehensive Analysis of Low-Rise Residential Buildings
- A-55** HVAC Distribution Systems in Commercial Buildings
- A-56** Building Specification Guidelines for Energy Efficiency
- A-56** Design Refinement and Demonstration of Market-Optimized Residential Heat-Pump Water Heater
- A-57** Removing the Key Technical Barrier to the Widespread Use of Advanced Absorption Cooling
- A-57** Improving Energy Efficiency of Commercial Kitchen Exhaust Systems
- A-58** Next-Generation Power Management User Interface for Office Equipment
- A-58** Instrumented Home Energy Rating and Commissioning
- A-59** Investigation of Secondary Loop Supermarket Refrigeration Systems

Industrial/Agricultural/Water End-Use Energy Efficiency Program Area

- A-59** Integrated Agriculture Technology
- A-60** Low Dross Aluminum Melter Project
- A-61** UV-Printing on Plastics
- A-61** Laboratory-Type Facilities
- A-62** Recycling Chiller-Bath Rinse Water in Poultry Processing

Renewable Energy Technologies Program Area

- A-63** Photovoltaic (PV) Chargeport Demonstration
- A-63** Photovoltaics
- A-63** Solar Two
- A-65** Powertherm, A Photovoltaic/Thermal Hybrid Commercial Roofing System
- A-65** Residential Electric Power Security
- A-66** Development of an Extended Induction Logging Tool for Geothermal Exploration and Field Development
- A-67** Hybrid Solar-Fossil Thermophotovoltaics
- A-67** PowerWheel Demonstration
- A-68** Power PV System Advanced Manufacturing Development and Scale-up
- A-68** Next Generation Wind Turbine Development Project
- A-69** Natural Gas Cofiring in Biomass Boilers
- A-70** Design and Optimization of a Solar-Fired Double-Effect Absorption Chiller
- A-71** Power Conditioning Unit (PCU) Test Center at PVUSA
- A-71** Utilization of Waste Renewable Fuels in Boilers with Minimization of Pollutant Emissions
- A-72** Collins Pine Cogeneration

Environmentally-Preferred Advanced Generation Program Area

- A-73** Distributed Resources Demonstration
- A-74** Fuel Cell Development and Demonstration

- A-74** Solid-Oxide Fuel Cell/Micro Turbine Generation Hybrid
- A-75** Micro-Turbine Generator (Distributed Generation)
- A-76** Low NO_x Gas Turbine Combustors for Distributed Power Generation
- A-76** Durability of Catalytic Combustion Systems
- A-77** A Novel Steam Reforming Reactor for Fuel Cell Distributed Power Generation
- A-77** 75-kW Molten-Carbonate Fuel Cell (MCFC) Stack Verification Test
- A-78** Energy Efficient, Low Emission, Cost Effective Micropilot Ignited Natural Gas Engine Driven GenSet for Deregulated, Distributed Power Generation Markets
- A-79** Ultra High Efficiency Packaged Microcogeneration System
- A-79** Megawatt-Class Pressurized Solid Oxide Fuel Cell/Gas Turbine Power System Demonstration Project
- A-79** Catalytic Combustor-Fired Gas Turbine for Distributed Power and Cogeneration Applications
- A-80** Expand and Utilize the Capacity of the National Fuel Cell Research Center Program

Energy-Related Environmental Research Program Area

- A-81** Regional Ambient Aerosol Studies (RAAS)
- A-82** Bird Strike Monitor
- A-83** Avian Powerline Interaction Committee
- A-83** Food Service Technology Center
- A-84** Wildlife Interactions with Utility Facilities
- A-85** Trenchless Burial Equipment
- A-86** Water and Wastewater Electrotechnologies
- A-87** Habitat and Species Protection
- A-88** Desert and Mountain Air Transport
- A-89** Formation of NO_x in Industrial Gas Burners
- A-90** Golden Eagles in a Perilous Landscape: Tracking the Effects of Mitigation for Energy Based Mortality
- A-90** Global Climate Change – California Implications and Potential Costs
- A-91** Electrotechnology Applications for Potable Water Production and Protection of the Environment

Strategic Energy Research Program Area

- A-92** Electric System Seismic Safety and Reliability
- A-93** Dynamic Circuit Thermal Line Rating (DCTR)
- A-93** System Stability and Reliability: Flexible AC Transmission Systems (FACTS) Benefits Study
- A-94** Phasor Measurement Units
- A-94** USAT MOD-2
- A-95** Energy Source Stabilizer (ESS)
- A-96** Substation Reliability
- A-97** Development of a Real-Time Monitoring Dynamic Rating System for Overhead Lines
- A-98** Development of a Composite Reinforced Aluminum Conductor
- A-98** 2 kWh Flywheel Energy Storage System
- A-99** Light Activated Surge Protection Thyristor (LASPT) for Distribution System Reliability
- A-99** Intelligent Software Agents for Control & Scheduling of Distributed Generation
- A-100** Sagging Line Mitigator (SLIM)

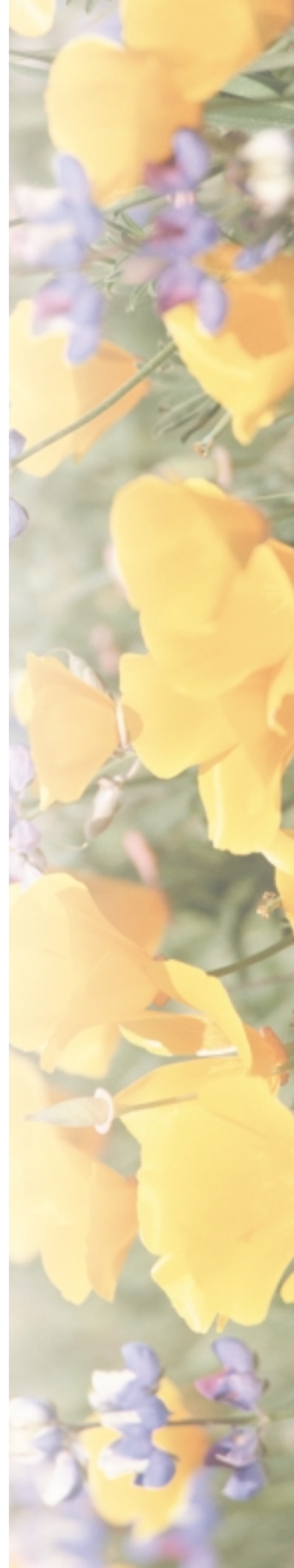
Projects Funded in 1998 through Collaborative Research with the Electric Power Research Institute

- A-100** Target 21 Municipal Water and Wastewater
- A-101** Target 22 Food Processing
- A-102** Target 23 Chemicals, Petroleum and Natural Gas

- A-104** Target 26 Agriculture
- A-105** Target 56 Grid Operations & Management
- A-106** Target 57 Grid Planning & Development
- A-107** Targets 61 Knowledge-Based Customer Metering; 61.1 Technology Development; and 61.2 Market Research and Services Development
- A-108** Targets 64.0 Distributed Resources (DR) Information and Tools for Business Strategy Development; 64.3 Distribution Planning Tools for Distributed Resources; and 64.4 Distributed Resources as a Risk Management Hedge in Retail Portfolios

1999-awarded **PIER**projects

- **Projects Funded through the PIER Program Areas**
- **Projects Funded through the Energy Innovations Small Grants Program**
- **Projects Funded through Collaborative Research with the Electric Power Research Institute**
- **Projects Funded through Collaborative Research with the Gas Research Institute**



PROJECTS FUNDED IN 1999 THROUGH THE PIER PROGRAM AREAS

Residential and Commercial Buildings End-Use Energy Efficiency Program Area

Interagency Project Title: CENTER FOR THE BUILT ENVIRONMENT (CBE)

Contract #: 400-99-001

Agency Partners: Armstrong World Industries; California Department of General Services; Henningson, Durham & Richardson, Inc.; International Facility Management Association; Johnson Controls, Inc.; Lucent Technologies; Ove Arup & Partners, Ltd.; Pacific Energy Center; Tate Access Floors, Inc.; U.S. Department of Energy; U.S. General Services Administration; the Webcor Team (Alfa Tech Consulting Engineers, Critchfield Mechanical, Rosendin Electric, and Webcor Builders); and York International Corporation.

Contract Amount: 1999: \$30,000
2000: \$30,000

Total Contract: \$60,000

Match Funding: 1999: \$498,750
2000: \$498,750

Total Match: \$997,500

Principal Project Manager: Kevin Powell, CBE Administrator, (510) 642-4950

Commission Project Manager: Elaine Hebert, (916) 654-4800

Project Description: The purpose of this project is to participate in the Center for the Built Environment (CBE), a university/industry/government collaborative based at the University of California, Berkeley (UCB) campus. CBE performs research in the areas of energy efficiency in buildings, the comfort of building occupants, healthy indoor air quality, and environments conducive to occupant productivity. Through studies of ventilation strategies, air flow, occupant productivity, computer-based occupant feedback mechanisms, space arrangement, and other factors, CBE intends to generate beneficial building and human response data to disseminate to architects, designers, mechanical and building engineers, government agencies, and other entities involved in creating indoor environments.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by encouraging energy efficiency in the heating, cooling, ventilation, and lighting of buildings.
- Improving the environmental and public health costs/risks of California's electricity by reducing pollution associated

with electricity generation through encouraging the efficient use of energy in buildings and providing healthier indoor environments by improving indoor air quality.

Proposed Outcomes:

- 1) Establishment of communications channels between building occupants and the designers and builders of buildings.
- 2) Buildings that have low energy needs and provide comfortable and healthy indoor environments conducive to occupant productivity.

Project Status: The collaborative research contract is signed and the project work is underway.

Project Title: ENERGY EFFICIENT AND AFFORDABLE SMALL COMMERCIAL AND RESIDENTIAL BUILDINGS PROGRAM

Contract #: 400-99-011

Contractor and Major Subcontractors: Architectural Energy Corporation (AEC) and Battelle-Pacific Northwest Division; The National Institute of Standards and Technology (NIST); Purdue University; Massachusetts Institute of Technology (MIT); Oak Ridge National Laboratory (ORNL); Schiller Associates; Heat-Timer Corporation; and Newport Design Consultants.

Contract Amount: \$1,747,000 (year 1)
\$1,816,000 (year 2)
\$1,859,000 (year 3)

Match Funding: \$2,541,000 (year 1)
\$2,108,000 (year 2)
\$1,738,000 (year 3)

Total Contract: \$5,422,000

Total Match: \$6,387,000

Contractor Project Manager: Vernon Smith, (303) 444-4149

Commission Contract Manager: Bryan Alcorn, (916) 654-4222

Project Description: The purpose of the Energy Efficient and Affordable Small Commercial and Residential Buildings Program is to develop, demonstrate and deploy science and technology solutions for building energy end-uses. The goal of the project is to substantially increase the energy efficiency

of California's existing and future building and housing sector. Solutions that provide direct and tangible benefits to California ratepayers will be researched. Key to achieving high impacts and direct benefits for every research dollar are projects that are market-oriented and supported by industry.

The Energy Efficient and Affordable Small Commercial and Residential Buildings Program will investigate the energy efficiency of buildings and will develop and demonstrate programs to improve energy efficiency. The program will address such issues as peak electrical demand, the need for better indoor environments, and the need to make California's commercial buildings and residential homes more affordable. It will also strengthen the growing energy efficiency industry in California by providing new jobs and growth opportunities for companies that provide the technology, systems, software, design, and building services to the commercial sector.

The program directly provides science and technology solutions that address a number of key PIER building energy-efficiency end-use program issues:

- Energy consumption is rapidly increasing in hotter, inland areas as new building construction increases in these areas.
- Development of energy efficient products and services needs to adequately consider non-energy benefits, such as comfort, productivity, durability, and decreased maintenance.
- Building design, construction, and operation of energy-related features can affect public health and safety.
- Investments in energy efficiency can affect building and housing affordability and value, and enhance the State's economy.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by allowing energy-saving measures to be integrated into the early design of a building, thereby making energy-efficient measures more cost effective; and
- Improving the reliability/quality of California's electricity by reducing peak demand and improving load factor, leading to reduced infrastructure costs and system reliability risks.

Proposed Outcomes:

- Automated commissioning and diagnostics to ensure efficient building operation and quality indoor environments.
- Advanced load management and controls to save energy and manage peak loads from buildings.

- Alternative cooling technologies to reduce or eliminate electric consumption for cooling.
- Alternative construction techniques and technologies to improve the efficiency and cost effectiveness of California's buildings.
- Technology assessment to target the research by determining impacts of and barriers to new technologies in California buildings, climates and markets.

Project Status: The Energy Commission approved funding for this project on December 1, 1999. A revised work statement, budget and contract are being finalized.

Project Title: HIGH PERFORMANCE COMMERCIAL BUILDING SYSTEMS PROGRAM

Contract #: 400-99-012

Contractor and Major Subcontractors: Lawrence Berkeley National Laboratory (LBNL) and Texas A&M University (TAMU), Massachusetts Institute of Technology (MIT), University of California, San Diego (UCSD), University of California, Berkeley (UCB), Davis Energy Group (DEG).

Contract amount: 1999/00: \$1,988,155
2000/01: \$1,999,074
2001/02: \$1,988,155

Total Contract: \$5,995,000

Total Match: \$3,093,000

Contractor Project Manager: Stephen Selkowitz,
(510) 486-5064

Commission Contract Manager: Martha Brook,
(916) 654-4086

Project Description: The purpose of the High Performance Commercial Building Systems Program is to develop and deploy a set of energy savings technologies, strategies, and techniques to help improve processes for designing, commissioning, and operating commercial buildings. The goal of this program is to reduce energy use in the California commercial sector by 22 percent by 2015. An important related goal is to provide significant economic benefits to building owners and health and performance benefits to occupants. At the same time this program will strengthen the growing energy efficiency industry in California by providing new jobs and growth opportunities for companies providing the technology, systems, software, design, and building services to the commercial sector.

The program directly provides science and technology solutions that address a number of key PIER energy-efficiency end-use program issues:

- Energy consumption is rapidly increasing in hotter, inland areas as new building construction increases in these areas.
- Development of energy efficient products and services needs to adequately consider non-energy benefits, such as comfort, productivity, durability, and decreased maintenance.
- Building design, construction, and operation of energy-related features can affect public health and safety.
- Investments in energy efficiency can affect building and housing affordability and value, and the state's economy.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by allowing energy-saving measures to be integrated into the early design of a building, thereby making energy-efficient measures more cost effective; and
- Improving the reliability/quality of California's electricity by reducing peak demand and improving load factor, leading to reduced infrastructure costs and system reliability risks.

Proposed Outcomes:

- Software tools to assist in building energy performance tracking and evaluation
- Software tools that will help identify building energy retrofit opportunities
- Improved user control of building lighting quality
- Increased ability to manage lighting electrical loads
- Tools to optimize low energy cooling system designs for commercial buildings
- Software tools, protocols and guides to facilitate successful building commissioning practices
- Mechanisms to detect and diagnose poor or faulty building energy system operation
- Quantification of attainable energy savings in relocatable classroom buildings
- Identification of volatile organic compounds (VOC) emission sources in relocatable classroom buildings

Project Status: The Energy Commission approved funding for this project on December 1, 1999. A revised work statement, budget and contract are being finalized.

Project Title: INTEGRATED ENERGY SYSTEMS PRODUCTIVITY AND BUILDING SCIENCE PROGRAM

Contract #: 400-99-013

Contractor and Major Subcontractors: New Building Institute (NBI) and Heschong Mahone Group; Eley Associates, Inc; Architectural Energy Corporation; GARD Analytics, Inc; RLW Analytics, Inc; SBW Consulting; Hamphill Industrial Technologies; Xenergy; M. Neils Engineering, Inc; Taylor Engineering; Florida Solar Energy Center; Energen Consulting, Inc.; Clanton Engineering, Inc; Cascadia Conservation; Energy, Environ, Economics; SDV/ACCI; Northwest Evaluation Associates; Tate Solar; Oakridge National Laboratories; Benya Light.

Contract Amount: year 1: \$1,949,255
year 2: \$1,995,950
year 3: \$1,937,848

Total Contract: \$5,883,053

Contractor Project Manager: Peter M. Schwartz,
(415) 924-1442

Commission Contract Manager: Gary Flamm,
(916) 654-2817

Project Description: The purpose of the Integrated Energy Systems Productivity and Building Science Program is to promote improvements to productivity or building science based on integrated systems research. Each element is designed to fill major gaps in the existing body of building science knowledge. It is not the individual element, but how they are assembled into and operated within a building system, that determines energy efficiency.

This project directly provides science and technology solutions that address a number of key PIER buildings end-use energy efficiency program issues:

- Encourage energy efficiency advances by supporting systems development activities that would not be readily undertaken by private developers.
- Program elements will be ready to be integrated into the market transformation programs when they are completed in three years.
- Solve systems integration problems that have been identified and move those solutions towards guidelines of advanced building practice. These solutions will then be available for adoption by market transformation programs and the private sector.
- Adopt solutions into codes and standards.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by allowing energy-saving measures to be integrated into the early design of a building, thereby making energy-efficient measures more cost effective; and

- Improving the reliability/quality of California's electricity by reducing peak demand and improving load factor, leading to reduced infrastructure costs and system reliability risks

Proposed Outcomes: The program proposes to develop design guidelines for the following issues:

- Quantify the impacts of daylighting on productivity in offices, sales in stores, performances of students in schools, and correlate to building energy use.
- Address the issues of commercial HVAC system integration, matching components using real world systems and best practices integration techniques.
- Identify problems with equipment and controls, distribution systems, and operation/maintenance practices that lead to poor system performance.
- Develop ceiling systems which optimize energy and non-energy considerations such as lighting, daylighting, acoustics, and structural factors.
- Develop standardized, prototype solutions for good ceiling systems design.
- Evaluate optimal duct placement and insulation levels in California homes.
- Develop solutions for residential ducting and air flow that can be acceptable to the building industry.
- Develop recommendations for improved energy efficiency of outdoor lighting in California.

Project Status: The Energy Commission approved funding for this project on December 1, 1999. A revised work statement, budget and contract are being finalized

Industrial/Agriculture/Water End-Use Efficiency Program Area

Interagency Project Title: ENERGY EFFICIENT AGRICULTURAL TECHNOLOGIES

Agreement #: 400-99-005

Agency Partners: University of California, Davis (UCD)

Commission Funding: \$1,793,000

UCD Project Manager: Jim Thompson, (530) 752-6167

Commission Project Manager: Ricardo Amon, (916) 654-4019

Project Description: The purpose of this project is to demonstrate the use of ozone as a substitute soil fumigant to replace chemical pesticides and as an alternative to aqueous toxic chemicals for fungi control in fruit packing plants. In addition, the project will investigate irrigation scheduling systems, precision farming technologies and innovative manure treatment technologies.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by increasing the efficiency of emerging electrotechnology applications in agriculture; and
- Improving the environmental and public health costs/risks of California's electricity by replacing toxic chemicals used in agribusiness with cleaner electrotechnologies.

Proposed Outcomes:

- 1) The Ozone Technology Project will research and develop methods to use ozone technology for agricultural applications.

Technology Path: This task will advance the development of ozone technology for agricultural and food applications. To date no comprehensive research has been accomplished to determine the cost-effective use of ozone technologies for agricultural applications. Applied research is necessary to achieve the highest level of energy efficiency by answering questions regarding: a) the ability of ozone to achieve the desired effects, b) the length of contact times between ozone and agricultural soil and products, c) the level of concentration of the ozone, and d) the affects of ozone on the produce. This research will be for virtually every specific fruit and vegetable and will be conducted under numerous processing and storage environments. The range of applications itself must be defined and the cost effectiveness and energy budgets must be derived and assessed.

Energy Efficiency Benefits: Researchers are developing energy efficient applications to improve the technology's cost effectiveness to make its use more attractive to farmers. The research will also provide a solution to the environmental pollution problems created by the industry's chemical-based practices.

In addition to furthering the efficient application of ozone as an agricultural technology, these projects will create an incentive for ozone equipment manufacturers to develop technologies that are more efficient. These projects can advance an emerging technology through new equipment development as well as improve its chances for adoption.

- 2) The Irrigation Scheduling Project will investigate and demonstrate state-of-the-art techniques of plant, soil, and atmospheric-based irrigation scheduling for orchard and vineyard crops.

Technology Path: This project will advance the development of irrigation scheduling practices in trees and vines throughout the growing season. At the completion of this project, the researchers expect the trunk diameter fluctuation technology to be ready for commercial use by innovative growers. Trunk Diameter Fluctuation is a device that can be used to measure the change in diameter of a tree trunk throughout the day to determine how much water the tree has used. A software system being designed for this technology will interpret the trunk diameter fluctuations readings and determine how much water to apply and when.

Energy Efficiency Benefits: Water for irrigation is the single largest energy user in the agricultural industry. Conducting applied research is imperative to minimizing water consumption, thereby reducing water-pumping costs to achieve the highest energy-use efficiency. Potential energy efficiency benefits to be gained from this research are estimated at 1.2 billion million kWhr per year. This estimate results from a 10 reduction in water used in tree and vine crops.

- 3) The Precision Farming Projects will research site-specific crop management systems by developing two new technologies: a) a soil compaction and moisture profile sensor for row crops and b) precision agricultural tools to optimize field production: Global Positioning Systems (GPS), Geographical Information Systems (GIS), and wireless technologies.

Technology Path: With the development of the soil compaction/moisture sensor, the researchers will demonstrate its usefulness in mapping infiltration variability and managing irrigation uniformity. Before commercialization can be realized, the researchers will need to demonstrate these methods at selected farm sites. This project will integrate the design, development and testing of soil compaction and moisture profile sensors to the GPS system to be developed in the second component of the project.

The second component of this project will continue the development and demonstration of electronic navigation and control technology to reduce the application rates of chemicals and fertilizers. This project will develop a prototype electronic interface between the GPS and the pulse-spray control module. The project will demonstrate the ability of the technology to minimize spray drift while applying chemicals in accordance with the GIS input map. At the completion of this project, the technology is expected to be ready for commercialization.

Energy Efficiency Benefits: The research will develop methods to enhance irrigation uniformity, conserve water, and reduce pumping energy requirements in row crops. The potential energy efficiency benefits to be gained from this research are estimated at 952 million kWhr/year. An additional 10-30 percent energy can be saved from a reduction in chemical use resulting in 25.2 to 75.6 million Btus saved per year. Environmental benefits result from reduced tractor fuel use as well as reduced leaching of nitrates and other groundwater contaminants.

- 4) The Dairy Waste Management Project will demonstrate an energy efficient, integrated wastewater management system for California livestock operations.

Technology Path: This research has the potential impact of reducing 46 tons/day of ammonia emission from the dairy industry and improving solid-liquid separation by 70 percent. The project will optimize the aeration process to achieve biological nitrification and denitrification for nutrient (ammonia) removal from liquid manure, and improve the solid-liquid separation process to remove organic and inorganic matter from the liquid manure. The project will demonstrate the technical feasibility of both technologies and assess the cost effectiveness and energy budgets for the processes. At the completion of this task, the technology is expected to be ready for commercialization.

Energy Efficiency Benefits: Potential energy benefits to be gained from this research are 255.5 million kWhr/year, because of more efficient aeration systems. Similar energy efficiency benefits can also be derived from swine and egg producing farms using the same technology. This project will address the most pressing environmental problems faced by California's dairy industry: manure management, nitrate contamination and ammonia emissions.

Project Status: The contract has been signed. Work authorizations for the project tasks are currently being drafted. Upon approval UCD will start the project. The contract term is from September 1, 1999 through December 31, 2004.

Energy-Related Environmental Research Program Area

Interagency Project Title: CENTRAL VALLEY OZONE STUDY

Contract #: 700-98-027

Contractor: California Air Resources Board (CARB)

Contract Amount: 1999: \$3,000,000

Contractor Project Manager: Andrew Ranzieri, (916) 324-4069

CEC Project Manager: Guido Franco, (916) 654-3940

Project Description: The purpose of this project is to participate, through an interagency agreement with the California Air Resources Board, in the Central California Ozone Study (CCOS) to gain a better understanding of the dynamics of the existing and expected ozone problem in Central California. Other participants in this study include several local air districts, the U.S. EPA, and private entities. The results of this study will shape the control strategies to be used in this region of California for at least the next decade. The area of study is much larger than that of earlier studies covering an area bounded by the Pacific Ocean to the west, the Sierra Nevada to the east, the end of the Sacramento Valley to the north, and the Mojave Desert to the south. The development of this information and modeling tools will also provide the opportunity to study new ways to use electricity to avoid or reduce air quality problems in this region.

This project supports the PIER program objective of:

- Improving the public health costs/risks of California's electricity by promoting a better understanding of the

dynamics of the existing and expected ozone problem in Central California.

Proposed Outcomes:

- Ensure that the appropriate data are collected and analytical models are developed to use in gaining a better understanding of the dynamics of the existing and expected future ozone problem in Central California.
- Develop better understanding of the role of thermal power plant plumes in contributing to regional air quality problems in Central California.
- Develop data and methods needed to assure the proper treatment of these plumes in models used to develop air quality management plans (AQMPs).
- Develop information that would be used for the development of workable interbasin/interpollutant offset trading rules for the Central California region. Historically, the absence of such rules has caused difficulties in the licensing of new power plants in California.
- Address the problem that regulatory agencies have been reluctant in allowing this type of offset trading due to the lack of adequate technical information and reduce the regulatory uncertainty for the licensing of new power plants.

Project Status: Project is on schedule, on budget and is expected to achieve proposed outcomes.

Strategic Energy Research Program Area

Sole-Source Project Title: ELECTRIC SYSTEM SEISMIC SAFETY AND RELIABILITY

Sole-Source Agreement #: 700-99-002

Contractors: Pacific Gas & Electric (PG&E) and the Pacific Earthquake Engineering Research Center (PEER)

Contract Amount: 1999/00: \$3,000,000
2000/01: \$1,500,000

Total Contract: \$4,500,000

Match Funding: PG&E: \$1,000,000
CalTrans: \$4,500,000

Total Match: \$5,500,000 (CalTrans up to \$4.5 million for 3 years)

PG&E/PEER Project Manager: Dr. William (Woody) Savage, (415) 973-3116

Commission Project Manager: Bob Anderson, (916) 654-3836

Project Description: The purpose of this project is to develop technologies and protocols to mitigate the vulnerability of electric systems to damage caused by earthquakes. Additionally, PG&E-PEER will develop assessment techniques to evaluate damage to electric systems caused by earthquakes and to assess fiscal impacts due to the loss of electric service to the community.

PEER is a consortium of 18 research universities located in California and other western states that has received National

Science Foundation support for research in earthquake engineering and related fields. The PG&E-PEER Business and Industry Partnership was formed in 1996 to address, in a user-driven manner, important earthquake issues encountered by electric utilities operating in earthquake-prone regions.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by reducing the vulnerability of the electric transmission and distribution system due to damage caused by a major earthquake, continuation of power in an area affected by an earthquake and/or by the rapid recovery of the electric service. This rapid recovery will allow for a shortened interruption to emergency services and businesses due to the loss of electric power.

Proposed Outcomes:

- Seismic Performance of Electric Substation Equipment: Develop a model and techniques to assess the performance of electric substation equipment during and after an earthquake.
- Electric System Seismic Risk: Develop a model for estimating the degree of functionality of the electric system after a major earthquake, leading to more efficient contingency plans.
- Electric System Building Vulnerability: Develop an assessment tool to determine whether the building stock associated with the electric system is capable of withstanding a major earthquake. This will lead to determining whether the buildings are capable of being seismically retrofitted or need to be replaced.
- Earthquake Ground Motion: Develop a tool that enables a reasonable assessment of ground motion given a potential earthquake so that other models can more accurately predict the impacts of an earthquake.
- Site Response: Develop a database of geologic and seismologic data to minimize the uncertainties in assessing soil structure interactions so the effects of strong ground motion can be developed for modeling utility equipment and system functionality.
- Permanent Ground Deformation: Develop assessment tools to determine the extent of ground rupture or failure due to strong ground shaking or to liquefaction. Utilities can determine the degree of risk due to soil failures at their facilities with respect to earthquake-induced, strong ground shaking.
- Emergency Response: Develop techniques to rapidly estimate the location and extent of strong ground shaking and resulting damage. This information will be used by

emergency responders and utilities in the deployment of emergency crews.

Project Status: The Commission approved the contract on the November 3, 1999. The final work statement and finalization of the contract terms and conditions are in process.

Intergovernmental Project Title: ELECTRIC SYSTEM RELIABILITY ENHANCEMENTS

Agreement #: 150-99-003

Agency Partners: Lawrence Berkeley National Laboratory (LBNL); and the Consortium for Electric Reliability Technology (CERTS); Oak Ridge National Laboratory (ORNL); Edison International; Power Systems Engineering Research Consortium (PSERC); Sandia National Laboratory (SNL); Electric Power Research Institute (EPRI); California Independent System Operator (CAISO).

Commission Funding: 1999/00: \$4,800,000
2000/01: \$2,400,000

DOE Match Funding: 1999: \$2,400,000
2000: \$2,400,000
2001: \$7,000,000

LBNL Project Manager: Joe Eto, (510) 486-7284

LBNL Project Contact: Rich Wilson, (510) 486-7391

Commission Contract Manager: Laiping Ng, (916) 654-4028

Project Description: The purpose of this project is to address the transition of California's electricity supply and delivery infrastructures from vertically integrated, regulated and government-controlled organizations to desegregated, competitive market-driven institutions. Power supply, network management and control systems are being driven to find new solutions to the traditional methods used to ensure stable power flows, frequency and voltage control. This intergovernmental agreement will provide integrated research and technology development that will help produce quicker and more flexible options for meeting the reliability, stability and ancillary service needs of California's electricity consumers

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity infrastructure by finding new solutions for a continued stable power supply for a deregulated electricity market; and
- Improving the energy cost/value of California's electricity by increasing the efficiency of California's competitive electricity market.

Proposed Outcomes:

- Maintain system reliability to California's electricity infrastructure at a loss of load probability (LOLP) of one-day-in-ten years.
- Evaluate the ability of distributed technologies, including issues regarding supply and demand, to improve system reliability.
- Improve and enhance access to California's electricity infrastructure for multiple generator and load types.
- Improve the ancillary services market connected to California's electricity infrastructure.
- Improve overall system efficiency of California's electricity infrastructure.
- Develop real time system management tools, including wide area monitoring systems (WAMS)

Project Status: This project was approved by the Energy Commission on December 15, 1999. The final work statement and finalization of the contract terms and conditions are in process.

Project Title: SECONDARY DISTRIBUTION SYSTEM IMPACTS OF RESIDENTIAL EV CHARGING

Sole-source Agreement #: 500-98-059

Agency Partners: Georgia Technology Research Corporation

Commission Funding: \$100,000

Match Funding: \$95,000

Project Manager: Frank Lambert, (404) 675-1855

Commission Project Manager: Mark Rawson, (916) 654-4671

Project Description: The purpose of this contract is to cost share a collaborative project to analyze the power quality impacts of large single-phase residential loads, such as electric vehicle chargers, computer equipment, appliances, and HVAC to residential secondary distribution (customer-side) systems.

The market penetration of these large single-phase residential loads is a concern to distribution utilities, electric power providers and consumers alike. To the power providers, it is a potential power quality, power delivery, and energy consumption concern. For the distribution utilities and consumers, it is a concern in terms of distribution system

reliability, house or site electrical system reliability, and energy costs.

Impacts of consumer appliances on the utility secondary distribution system are network externalities. Electricity providers have no regulatory responsibility for network externalities. However, electricity providers do recognize the importance of this issue and are costsharing this project. The collaborative includes Southern California Edison, Pacific Gas and Electric, Sacramento Municipal Utility District, Virginia Power, Southern Company, and Florida Light and Power.

The data provided by this study are expected to be useful to: 1) utility planners anticipating the increasing penetration of large loads in residential settings, 2) equipment manufacturers as guidance in determining the necessary performance standards to ensure compatibility with the electrical supply system, and 3) policy makers seeking to comply with state and federal energy policies. The Energy Commission can also use the data provided to determine if additional appliance standards are necessary. A summary of the key findings of the study is expected to be published and disseminated in an identity-protected format through the National Electric Vehicle Infrastructure Working Council and other organizations.

This project supports the PIER Strategic Research Program objectives of:

- Improving the reliability and efficiency of the California's electrical transmission, distribution and delivery grid.

Proposed Outcomes:

Data Collection: Develop a matrix of expected appliances that are representative of the population mix and capture electric power quality profiles for nominal and undervoltage conditions.

Model Development and Validation: Develop simulation models for the electrical appliances and secondary distribution transformer circuits provided by each participating utility. Validate simulated results using measured data from the test homes under similar loading conditions.

Case Studies: Develop case studies (worst, best and typical) that are representative of electrical service configurations provided by utilities. Evaluate the utility distribution transformer, secondary distribution conductors, and service conductors for both de-rating and line losses due to the increase in harmonic currents. Also, evaluate the impact to quality of service for both the customer using the harmonic loads and their neighbors that share the same secondary.

Site Testing And Validation: Establish field test sites for each of the California utilities and monitor the power quality characteristics of the secondary, customer and neighbor's electrical system. Analyze field data and compare to predicted results.

Project Status: The collaborative partners funded Phases 1 and 2 that are now completed. At present, Phase 3 is complete and Phase 4 is halfway completed. The project is on schedule, within budget and is expected to reach its objectives. The term of the project is from May 19, 1999 until June 30, 2000.

PROJECTS FUNDED IN 1999 THROUGH THE ENERGY INNOVATIONS SMALL GRANTS PROGRAM

EISG Project Title: ELECTROSYNTHESIS OF DEVICE QUALITY SEMICONDUCTOR FILMS

EISG Grant Number: 99-01

PIER Area: Renewable Energy Technologies

Principal Investigator: Shalini Menezes, (805) 492-9814

Organization: InterPhases Research

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 18 Months

Project Description: The purpose of this project is to research the feasibility of an innovative electrochemical process that could be used in fabricating high quality thin films for copper indium diselenide photovoltaic (PV) modules. The process is designed to be simpler and more cost effective than current thin-film PV processes and is capable of being scaled up to large-area modules for manufacturing purposes.

Proposed Outcomes:

- Methodology for synthesizing consistent high quality copper selenide (CuSe) films using a new electro-deposition process.
- Precise control of film growth by regulating cycles using a specially designed diffusion layer deposition apparatus.

Anticipated Benefits:

- Reduce the cost of manufacturing large-area copper indium diselenide (CIS) PV modules.
- Eliminate expensive vacuum processing and vapor deposition procedure.

- Thin-film PV technologies, such as copper indium diselenide, are projected to reduce PV manufacturing costs by 75 percent.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: VENTILATION MEASUREMENT AND CONTROL

EISG Grant Number: 99-02

PIER Area: Building End-Use Efficiency

Principal Investigator: Clifford Federspiel, (510) 526-7484

Organization: Federspiel Controls

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$74,970

Grant Term: 5 Months

Project Description: The purpose of this project is to research the feasibility of producing a prototype, air flow measurement device for ventilation systems that is energy efficient, accurate, cost effective and maintenance free. This technology will be used to measure and control outdoor intake airflow rates, exhaust airflow rates and the airflow rates supplied to occupied spaces in buildings.

Proposed Outcomes:

- Prototype air flow device capable of measuring actual air flow within +/- 10 percent over the full range of operating conditions.
- Control logic and methodology for fan pressure resetting and demand-controlled ventilation.

Anticipated Benefits:

- Design that is less prone to fouling, is sensitive to variations in airflow velocity distribution within the duct, and requires less maintenance.
- Reduce the cost to manufacture and install using low cost components and eliminate the need for a separate duct section dedicated to airflow measurement.
- Potential to reduce energy consumption in California by .055 quads (1 quad = 2.93 X 10¹² kWh), of which .035 quads is related to reduced electrical consumption equivalent to \$326 million per year.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: CONTROL OF ON-OFF EQUIPMENT IN BUILDINGS

EISG Grant Number: 99-03

PIER Area: Building End-Use Efficiency

Principal Investigator: David Auslander, (510) 642-4930

Organization: University of California, Berkeley

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 16 Months

Project Description: The purpose of this project is to research the feasibility of using new control strategy for the operation of On-Off HVAC systems and subsystems within commercial buildings. The control logic would be designed to minimize start-stop cycling frequency while ensuring that the variation in the process remains within acceptable limits.

Proposed Outcomes:

- Computer simulation that establishes the energy efficiency, temperature variation and maintenance impact of the proposed control strategy that incorporates state transition logic of multi-stage HVAC equipment and capacity control logic.
- Performance comparison of the new control logic with existing level-crossing logic.

Anticipated Benefits:

- Increase the operating efficiency and reduce maintenance costs of HVAC and refrigeration systems through improved control logic that reduces the cycling frequency.

- Potential to reduce energy consumption in California by .15 quads (1 quad = 2.93 X 10¹² kWh), of which .084 quads would be related to reduced electrical consumption equivalent to \$1.97 billion per year.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: PROCESS FOR CONVERTING SEWAGE SLUDGE AND MUNICIPAL SOLID WASTES TO CLEAN FUELS

EISG Grant Number: 99-04

PIER Area: Environmentally Preferred Advanced Generation

Principal Investigator: Radon Tolman, (505) 982-9912

Organization: Environmental Energy Systems Inc.

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 7 Months

Project Description: The purpose of this project is to research the feasibility of producing hydrogen and other clean fuels from wet biomass, sewage sludge and municipal solid wastes. The system would use the output of an aerobic (oxygen present) digester in combination with an innovative heat recovery steam generator that uses a water gasification process which is capable of accepting solutions of minerals and metals in slurries and emulsions without corrosion and deposition on heat transfer surfaces.

Proposed Outcomes:

- Quantify and analyze the liquids, gases and solid residues produced from a bench-scale prototype using the output of an aerobic digester as the feedstock.
- Quantify the fuel values and requirements for additional cleaning / treatment of the resulting fuels for use in gas turbines for electric generation.
- Assess the mass and energy balance, system optimization and economic feasibility.

Anticipated Benefits:

- Achieve 40 percent thermal efficiency in processing wet biomass sludge into electric power.
- Reduce quantity of secondary waste requiring landfill disposal. A typical sewage treatment plant- such as the plant in Encina, California- produces 90-100 metric tons per

day of secondary waste and pays \$24 per wet ton for landfill disposal.

- Reduce need for landfill leachate collection and treatment and landfill gas recovery.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: NEW GENERATION THERMOELECTRIC MATERIALS FOR POWER GENERATION AND REFRIGERATION

EISG Grant Number: 99-05

PIER Area: Environmentally Preferred Advanced Generation

Principal Investigator: Angelica Stacy, (510) 642-3450

Organization: University of California, Berkeley

Commission Program: Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$74,994

Grant Term: 18 Months

Project Description: The purpose of this project is to research the feasibility of fabricating a thermoelectric material into a layer of microscopic unidirectional wires that are oriented perpendicular to the first layer which, in theory, should improve the conversion efficiency of generating electricity directly from heat. Thermoelectric power generators are produced by joining two thermoelectric materials with opposite charge carriers and applying heat to one side.

The thermoelectric fabrication be accomplished through the precise, electrodeposition of Cobalt Antimonide (CoSb₃) into a porous template. The objective is to produce a higher-efficiency thermoelectric material that can be used in power generation and refrigeration.

Proposed Outcomes:

- Optimized methodology for electrodeposition of CoSb₃ in a porous alumina template.
- Assessment of the thermoelectric properties of a fabricated array of CoSb₃ nanowires using electrodeposition.

Anticipated Benefits:

- Improve the efficiency of thermoelectric materials above the current state of the art by 10 percent.

- Advantages of thermoelectric power generation include: no emissions, no moving parts, quiet operation and can operate from waste heat.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: RENEWABLE HYDROGEN FUEL PRODUCTION BY MICROALGAL PHOTOSYNTHESIS

EISG Grant Number: 99-06

PIER Area: Renewable Energy Technologies

Principal Investigator: Anastasios Melis, (510) 642-8166

Organization: University of California, Berkeley

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 18 Months

Project Description: The purpose of this project is to research the feasibility of increasing hydrogen production from the photosynthesis of algae. Three promising methodologies will be investigated: the effect of shifting the chemical equilibrium of the reaction, modifications to the growth media and the effect of diurnal cycles.

Proposed Outcomes:

- Optimized methodology for producing hydrogen from algae and sunlight.
- Solution for stopping photosynthetic oxygen production during the hydrogen production phase, which is important since the presence of oxygen prevents the formation of enzymes needed for the production of hydrogen.

Anticipated Benefits:

- Increase hydrogen production efficiency from the current 10 percent to 20 percent of the theoretical maximum.
- Establish of a commercially sustainable H₂ production methodology utilizing green algae and sunlight.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: SUNGUARD: ROOFING TILE FOR NATURAL COOLING

EISG Grant Number: 99-07

PIER Area: Building End-Use Efficiency

Principal Investigator: Tom Dinwoodie
(510) 540-0550, extension 227

Organization: PowerLight Corporation

Commission Program Manager: Philip Misemer
(916) 654-4552

SDSU Program Administrator: Hal Clark (619) 594-1158

Grant Amount: \$74,885

Grant Term: 12 Months

Project Description: The purpose of this project is to research the feasibility of an innovative residential roofing tile that will significantly reduce roof deck temperatures through passive convection and reflective means. Computer modeling and simulations will be performed and roof tile prototypes will be fabricated and tested.

Proposed Outcomes:

- Optimized roof tile design that possesses the desired conduction, radiation and convection heat transfer properties.
- Prototype roof tile capable of maintaining roof deck temperature at or below ambient temperature.

Anticipated Benefits:

- Projected annual energy savings of \$24-\$490 for a 2,000 sq-ft home depending on home construction and location.
- May permit the sealing of attic spaces in locations with high humidity for better moisture control.
- Tile design may be integrated with PV for added energy savings.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: MODELING GREENHOUSE TEMPERATURE FOR ENERGY EFFICIENT PRODUCTION

EISG Grant Number: 99-08

PIER Area: Industrial/Agriculture /Water End-Use Efficiency

Principal Investigator: J. Heinrich Lieth, (530) 752-7189

Organization: University of California, Davis

Commission Program Manager: Philip Misemer,
(916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 12 Months

Project Description: The purpose of this project is to research the feasibility of creating models that accurately predict the effect of varying energy-related climate conditions on the growth of different hothouse plants. The models could then be used in computerized controls that allow HVAC systems to operate only when required to optimize plant growth or prevent plant damage.

Proposed Outcomes:

- A dynamic greenhouse energy model that quantifies the efficiency of external energy input under various climatic scenarios.
- Strategies for greenhouse temperature control that create satisfactory crop value with minimal energy cost.

Anticipated Benefits:

- Improve energy efficiency of greenhouse operations by 20 percent.
- Improve the competitive position of domestic greenhouses that are experiencing increased competition from overseas.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: A NEW GAS TURBINE ENGINE CONCEPT FOR ELECTRICITY GENERATION WITH INCREASED EFFICIENCY AND POWER

EISG Grant Number: 99-09

PIER Area: Environmentally Preferred Advanced Generation

Principal Investigator: W. A. Sirignano, (949) 824-3700

Organization: University of California, Irvine

Commission Program Manager: Philip Misemer,
(916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 18 Months

Project Description: The purpose of this project is to

research the feasibility of an innovative gas turbine design that extends combustion into the turbine sections. This design process has the potential to significantly increase thermal efficiency and specific power output of gas turbines. This project will include a detailed cycle analysis to include turbine inlet temperature, pressure ratio and power distribution in the turbine stages and aerothermodynamic and combustion analysis on the flow through the turbine blades.

Proposed Outcomes:

- Optimized gas turbine design configuration.
- Identify technological obstacles that need to be overcome to advance the concept to the next level.

Anticipated Benefits:

- Increase thermal efficiency of gas turbines to 65 percent, a 15-20 percent increase over conventional engines used for electrical generation. This represents a significant increase in the percentage of the heat energy in the natural gas fuel that is converted to electrical energy.
- Increase the specific power by 100 percent over conventional engines, which allows engines to be built smaller, resulting in lower capital costs.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: DEVELOPMENT AND CHARACTERIZATION OF IMPROVED SOLID STATE DYE-SENSITIZED NANOCRYSTALLINE SOLAR CELLS

EISG Grant Number: 99-10

PIER Area: Renewable Energy Technologies

Principal Investigator: Jin Zhang, (831) 459-3776

Organization: University of California, Santa Cruz

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 18 Months

Project Description: The purpose of this project is to research the feasibility of two innovations to reduce the cost and improve the reliability and maintainability of nanocrystalline dye-sensitized solar cells. In this type of solar cell, sunlight is absorbed by the dye, which transfers electrons to titanium oxide particles that pass the electrons to the con-

ductive layer on the glass. A liquid solution (electrolyte/redox mediator) is used to regenerate the dye. This project will investigate (1) use of a solid polymer film in place of the liquid electrolyte/redox mediator and (2) use of natural water-based non-toxic pigments. Four promising transparent conjugated polymers will be fabricated and tested.

Proposed Outcomes:

- Prototype nanocrystalline dye-sensitized solar cell built with a solid polymer film in place of liquid electrolyte/redox and a natural water-based pigment.
- Identify technological obstacles that need to be overcome to advance concept to the next level.

Anticipated Benefits:

- Increase the operational life of nanocrystalline dye-sensitized solar cells beyond the current limit of 7000 hours. Limitation is due to the instability of the liquid electrolyte/redox media.
- Advantage of nanocrystalline dye-sensitized solar cells is that they can be fabricated using inexpensive materials and little specialized equipment, making them attractive to both industrialized and developing nations.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: ACTIVELY CONTROLLED JET INJECTION IN GAS TURBINE ENGINES

EISG Grant Number: 99-11

PIER Area: Environmentally Preferred Advanced Generation

Principal Investigator: Ann Karagozian, (310) 825-5653

Organization: University of California, Los Angeles

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$74,899

Grant Term: 18 Months

Project Description: The purpose of this project is to research the feasibility of using actively controlled dilution air jets that deliver pulsed air perpendicular to the intake air flow in the primary zone of a gas turbine's burner to rapidly produce a lean mixture. Dilution air jets are used in gas turbines for temperature control and NOx reduction through air-fuel mixture ratio control. This project builds upon prior

work that modeled pulsed transverse jet flow, and will develop control strategies based on simulations followed by experimental validation using a bench-scale combustor.

Proposed Outcomes:

- Optimal open and closed loop control strategies for pulsed transverse dilution jets to achieve maximum reduction of NOx emissions.
- Combustor design specifications for incorporating pulsed air jets, actuators and sensors.

Anticipated Benefits: Reduce NOx emissions in gas turbines 50 percent by maintaining a constant lean air-fuel mixture.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: OMNI SMARTPUMP

EISG Grant Number: 99-12

PIER Area: Industrial/Agriculture/Water End-Use Efficiency

Principal Investigator: B. C. MacDonald, (707) 937-4352

Organization: Omni Instruments

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 16 Months

Project Description: The purpose of this project is to research the feasibility of using prototype, high-efficiency, variable-speed electric motors with programmable control electronics and pressure sensors to more energy efficiently provide constant optimal pressure to a closed loop drip irrigation system. The use of a standard single speed motor running at full power wastes electrical energy when it delivers either too much or too little water pressure. This project will fabricate and bench test 3-4 prototype systems in the two horsepower power range that incorporate variable speed AC and DC motors, digital controllers, pump heads and external sensors. One or more of the designs will be field-tested under real world conditions.

Proposed Outcomes:

- Prototype variable speed irrigation pump optimized for drip irrigation applications.
- Compare the energy efficiency of prototype systems with conventional irrigation pumping systems.

- Identify the technological obstacles to scaling up large AC motors for variable speed operation for use in drip irrigation.

Anticipated Benefits:

- Improve the energy efficiency and cost of drip irrigation pumping systems by eliminating the need for a separate pressure tank while maintaining a constant optimal water pressure.
- Motor control technology can be scaled up to include large AC motors used in large-scale irrigation operations.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: IMPROVED OPERATIONAL TURNDOWN OF AN ULTRA-LOW EMISSION GAS TURBINE COMBUSTOR

EISG Grant Number: 99-13

PIER Area: Environmentally Preferred Advanced Generation

Principal Investigator: Scott Smith, (408) 727-8282

Organization: Alzeta Corporation

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$74,103

Grant Term: 6 Months

Project Description: The purpose of this project is to research the feasibility of a new, lean-premix gas turbine combustor design that permits precise local control of the air-to-fuel ratio which improves the operating range of the combustor and significantly reduces NOx emissions. The project includes fabrication and testing of up to four prototype combustor configurations and the development and testing of potential control strategies.

Proposed Outcomes:

- Prototype lean-premix gas turbine combustor capable of meeting targeted emissions levels.
- Optimized fuel/air control strategy for prototype combustor.

Anticipated Benefits:

- Reduce NOx, CO and hydrocarbon emissions in lean-premixed gas turbine combustors to 5 ppm, 10 ppm and 10 ppm, respectively.

- California relies heavily on gas turbines for electric generation and low emission gas turbines are expected to play a major role in distributed generation.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: LOW COST MICROCHANNEL REFORMER FOR HYDROGEN PRODUCTION FROM NATURAL GAS

EISG Grant Number: 99-14

PIER Area: Environmentally Preferred Advanced Generation

Principal Investigator: Darby Makel, (530) 895-2771

Organization: Makel Engineering, Inc.

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 12 Months

Project Description: The purpose of this project is to research the feasibility of fabricating prototype microchannel reformers for converting natural gas to hydrogen for use in fuel cells. Innovative fabrication strategies will be investigated and tested.

Proposed Outcomes:

- Two prototype reformers that employ different fabrication strategies.
- Performance results from prototype tests.
- Methodology for fabricating small, low-cost, scaleable natural gas reformers.

Anticipated Benefits:

- Enable the mass production of low cost natural gas reformers, thus significantly reducing the manufacturing cost of integrated fuel cells.
- Enabling technology that would allow small residential and commercial fuel cells to operate from the abundant and inexpensive natural gas supplies in California.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: FEASIBILITY OF SOLAR FIRED, COMPRESSOR ASSISTED ABSORPTION CHILLERS

EISG Grant Number: 99-15

PIER Area: Building End-Use Efficiency

Principal Investigator: James Bergquam, (916) 383-9425

Organization: Bergquam Energy

Commission Program Manager: Philip Misemer, (916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 18 Months

Project Description: The purpose of this project is to research the feasibility of improving the performance and reducing the cost of solar heated absorption chillers by incorporating a small vapor compressor into the design. Candidate vapor compressors will be identified and tested. This project targets small- to medium-sized commercial buildings with cooling loads up to 100 tons.

Proposed Outcomes:

- An improved design for single and double effect solar heated absorption chillers that will reduce their operating temperatures below 140 degrees F and 250 degrees F respectively.
- Identify off-the-shelf compressors or specifications for a custom compressor that will perform the required function.

Anticipated Benefits:

- Reduce the cost of the systems by eliminating the need for high pressure components that are required for systems operating above 250 degrees F.
- Reduce system payback period from eight years to less than five years.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: ENERGY SHAVER – A THERMAL ENERGY STORAGE DEVICE FOR AIR CONDITIONERS

EISG Grant Number: 99-16

PIER Area: Building End-Use Efficiency

Principal Investigator: James Lester, (970) 963-2517

Organization: Redstone Engineering Consulting Inc.

Commission Program Manager: Philip Misemer,
(916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$74,695

Grant Term: 6 Months

Project Description: The purpose of this project is to research the feasibility of increasing the efficiency of residential air conditioners through the use of a phase change material (salt hydrate) to augment the cooling of the condensed Freon. A subscale prototype of the proposed heat exchanger will be fabricated and tested. The system will be designed as a retrofit package for existing air conditioning systems.

Proposed Outcomes:

- Mathematical model of the proposed air conditioning system to verify efficiency improvements.
- Design for an efficient, low-cost heat exchanger capable of cooling the condensed Freon to 85 degrees F.

Anticipated Benefits:

- Increase the operating efficiency of residential air conditioners by up to 30 percent.
- Potential to reduce peak electric consumption in California through passive means by exploiting the large differential in day and night time temperatures that exists in the hottest regions of California and the Southwest United States.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

EISG Project Title: HIGH SPEED LIGHT ACTIVATED ON/OFF THYRISTOR

EISG Grant Number: 99-17

PIER Area: Strategic Energy Research

Principal Investigator: David Giorgi, (619) 452-8787

Organization: OptiSwitch Technology

Commission Program Manager: Philip Misemer,
(916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$74,900

Grant Term: 6 Months

Project Description: The purpose of this project is to research the feasibility of developing an all-light controlled on/off thyristor power switch. A thyristor is an electronic device that conducts electricity in one direction only. This effort leverages prior development of a light activated switch capable only of turn-on that was developed for surge protection applications. This effort will add turn-off capability to the light activated switch thereby extending its potential use into a wide range of electrical devices, such as inverters, filters, pulse-width modulators, etc., that can benefit from smaller, lighter, and more efficient high-speed power switches. Preliminary physical tests will be performed to demonstrate feasibility.

Proposed Outcomes:

- Using 2D-simulation code, a mathematical model will be developed of the light controlled thyristor.
- Specifications for required laser light source.
- Process steps for device fabrication.

Anticipated Benefits:

- Increase turn-off current density capability over existing thyristor switches by a factor of four to 100 A/cm² (amps per square centimeter) while maintaining a 1μs (micro-second) turn-on time.
- This technology will enable power switches to be made smaller and lighter than existing switches, which should reduce manufacturing costs.
- Light activated switches are more reliable because they are not susceptible to faulty triggering from electrical noise.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation and work on the project has commenced.

EISG Project Title: POWER QUALITY AND ENERGY CONSERVATION THROUGH POWER FACTOR CORRECTION

EISG Grant Number: 99-18

PIER Area: Industrial/Agriculture/Water End-Use Efficiency

Principal Investigator: Arthur Iversen, (408) 354-7972

Organization: Spinel LLC

Commission Program Manager: Philip Misemer,
(916) 654-4552

SDSU Program Administrator: Hal Clark, (619) 594-1158

Grant Amount: \$75,000

Grant Term: 12 Months

Project Description: The purpose of this project is to research the feasibility of developing a low cost, solid state circuit using Insulated Gate Bipolar Transistors (IGBTs) capable of maintaining optimal power factor in the presence of random multiple motor loads that would be typical in light industry settings. This project proposes an innovative way of paralleling the IGBTs that enable the system to be scaled up at low cost. A prototype system will be built and tested. Unity power factor occurs when voltage and current both cross zero at the same time within each cycle of alternating current (power factor 1.0). End user motor load inductance causes the voltage and current to fall out of sync (non-unity power factor), and if not corrected, more electrical current is required to operate the motors.

Proposed Outcomes:

- Subscale prototype demonstration of IGBT power factor correction system.
- System design that can be scaled up to a 100kv capacity.

Anticipated Benefits:

- Provides a cost effective solution for small- to medium-size industries to install power factor correction systems that can significantly reduce their electrical costs. Electric motors account for 58 percent of all electrical consumption. Considering that the average industrial motor operates at a power factor of .85, this equates to about \$180 million/year in avoidable electrical costs to California end users.
- Wide-spread use of power factor correction reduces system-wide current draw, thus reducing the need for expansion of electrical distribution infrastructure. The faster response time of IGBTs over existing Silicon Controlled Rectifier (SCR) technology results in greater protection for the end user against switching transients and system resonance which can cause equipment damage.

Status: The contractor has signed a grant agreement with the San Diego State University Foundation, and work on the project has commenced.

PROJECTS FUNDED IN 1999 THROUGH COLLABORATIVE RESEARCH WITH THE ELECTRIC POWER RESEARCH INSTITUTE

(NOTE: IN ADDITION TO THESE NEW 1999 PROJECTS, ALL 1998-FUNDED EPRI PROJECTS WERE AUGMENTED IN 1999 AND EXTENDED THROUGH 2000)

Project Title: TARGET 1 RESIDENTIAL HEAT PUMP TECHNOLOGY

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; D.W. Abrams, P.E. & Associates; P.C.; OG&E Electric Services Company; Oregon Department of Energy; Saturn Resource Management; Southern California Edison Co.

Contract Amount: 1999: \$281,000
2000: \$281,000
Total: \$ 562,000

Match Funding: 1999: \$1,129,818
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Carl Hiller, (530) 758-3035

Commission Project Manager: Martha Brook,
(916) 654-4502

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to support EPRI's continuing development of high-performance

(energy efficient) heat pumps and their efforts to deliver quality data and services to invigorate the market. Working with manufacturers and research partners, EPRI is supporting production of climate-wise air and geothermal heat pumps, demonstrating heat pump applications, verifying performance and energy efficiency, and pursuing refinements to the "Insider" heat pump, a compact unit for multifamily and manufactured housing. This target also delivers products on duct system design and duct sealing technology to further reduce energy waste, and collaboration on a national technician certification program to address installation and customer satisfaction issues.

EPRI's collaborative program impacts technology development and heat pump infrastructure nationally. This, in turn, benefits California users to ensure a continued positive market environment for residential heat pumps. The Commission will receive technical information and persuasive promotional materials for local educational activities to stimulate residential customer's interest.

- This project supports the PIER Program objectives of:
- Improving the energy cost/value of California's electricity by developing and enhancing the performance and

efficiency of residential heat pump technology to reduce the energy needs for space heating and cooling applications; and

- Improving the environmental and public health costs/risks of California's electricity by reducing energy use, which in turn decreases power generation emissions, and by supporting the changeover from ozone depleting refrigerants to Zero Ozone Depletion Potential (ZODP) fluids.

Proposed Outcomes:

Increase the use of Zero Ozone Depletion Potential (ZODP) Refrigerants

- Develop communications products to transfer research results to HVAC community, manufacturers, energy suppliers, etc. These materials will improve utility and HVAC industry knowledge regarding ZODP refrigerants in order to facilitate switching over to these new refrigerants.

Increase the potential for the use of Air-Source Heat Pumps

- ZODP Air-Source Heat Pump: This target provides field and reliability test results of high-efficiency air-source heat pump, using ZODP refrigerants and incorporating advanced features. Development cofunded with manufacturer.

Provide market-ready enhanced, integrated heat pumps

- Enhanced, Integrated Heat Pump: Prototype and commercial hardware for multifamily housing; marketing meeting with energy companies and manufacturers and prototype hardware and commercial hardware for manufactured housing
- Single-package Heat Pumps: 12 SEER Insider for multi-family housing market, customer research on market acceptance, and marketing workshop

Provide a Technician Certification program to improve the likelihood of heat pump selection and proper installation

- Cooperate with industry in developing a voluntary, national certification program for service technicians. (TC funded program evaluation)

Increase the potential for use of Ground-Source Heat Pumps (GHP)

- Ground-Source Heat Pump (GHP) Technology Transfer: Teleconferences to disseminate information and encourage market infrastructure, and participation in codes and standards development
- Technology Demonstrations: GHP system field demonstrations to show the effectiveness of these systems

- Ground-Source Heat Pump Information: GHP Manual update, and GHP Manufacturers Directory (updated annually).
- Continuing support of the International Ground Source Heat Pump (IGSHPA) Association and the Geothermal Heat Pump Consortium (GHPC) as focal points for technology transfer.

Increase the potential for use of Thermal Distribution Systems Development and Applications

- Hydronic Thermal Distribution: Data from a field demonstration and development of a commercial product.
- Duct Installation Training and Education: Training manual for improved duct system installation; designed to improve customer satisfaction with installations

Improve the accuracy of heat pump and air conditioner modeling throughout the range of California climates

- Develop heating, cooling and water heating performance maps for air source and ground source heat pumps, and algorithms to implement them into CALRES and other building design programs.
- Establish more equitable comparisons for high efficiency vs. standard efficiency heat pumps and air conditioners and provide equitable comparisons of the energy implications across fuel types, establishing an accurate basis for judging time-of-use energy consequences of California housing.

Project Title: TARGET 7 COMMERCIAL HEAT PUMP/AIR CONDITIONING TECHNOLOGY

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Lennox Industries; Climate Master, Inc.; BKI; Joint Center for Energy Management-University of Colorado; Alliant Energy, Bevilacqua-Knight Inc; Geothermal Design & Engineering, Inc.

Contract Amount: 1999: \$180,625
2000: \$180,625

Total Contract: \$361,250

Match Funding: 1999: \$1,186,322

Total Match: \$1,186,322
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Mukesh Khattar, (650) 855-2899

Commission Project Manager: Martha Brook, (916) 654-4086

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to continue developing higher-efficiency, climate-wise refrigerants for the commercial heat pump and unitary air conditioner market. In California, this accounts for approximately one-third of the commercial sector's electricity use. Manufacturers are slowly developing electric equipment for the best refrigerants emerging from research. The slow pace of equipment development is a barrier to the broader use of commercial heat pumps, the most energy efficient space heating and cooling technology. This project includes developing environmentally superior heat pumps, water-loop, and geothermal systems, and improving indoor air quality and dehumidification. The target also includes work on improved refrigerants and equipment to achieve greater comfort, lower noise, and lower capital and operating costs.

The EPRI Heating, Ventilating, Air-Conditioning, and Refrigeration (HVAC&R) Center will provide consulting resources, communication materials, training, and services to meet customer needs cost effectively. The Center will also participate in developing codes and standards to ensure that heat pumps and air conditioners are properly assessed and represented.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by developing and enhancing the performance and efficiency of heat pump technology for space heating and cooling applications; and
- Improving the environmental and public health costs/risks of California's electricity by reducing energy use which in turn decreases power plant emissions and supporting the changeover from ozone-depleting refrigerants to zero ozone-depleting (ZODP) fluids.

Proposed Outcomes:

Increase the market penetration of energy efficient heat pumps and new air conditioning technologies through practical technical information.

- **Technology Transfer Materials and Delivery Systems:** Technical papers, InfoBriefs, tutorial TechTips, project updates, and bulletins per mail, fax, e-mail, and/or EPRIweb as appropriate to provide the Commission staff with the latest information and project results that can be shared with California ratepayers
- **Access to HVAC&R Center.** The Energy Commission's access to the technical expertise of this center can be used to enhance existing Commission energy efficiency

activities, answer HVAC&R related questions more quickly, and inform Commission staff of advanced technologies and their performance capabilities.

Expand the market share of energy efficient heat pump technology by developing and introducing products with substantially improved comfort, efficiency, and environmental impact into the market.

- **EPRI will implement emerging zero-ozone depleting potential (ZODP) refrigerant replacements** in both air- and water-source heat pumps and air conditioners and provide practical technical information and tools to assist in market introduction of new technologies.
- **ZODP Unitary Heat Pumps:** Implement ZODP replacements for R-22 in air-source heat pumps (Lennox L-series). Includes refrigerant testing in existing designs, equipment optimization, design, and market studies with manufacturers, hardware development, and field tests.
- **ZODP Refrigerants:** Develop and test to identify best options and verify performance (joint program with others).
- **Integrated Solution Assessment:** Optimize use of new component technology (e.g., 2-speed compressors) in heat pump and air conditioner systems.

Increase the energy efficiency options for California rate-payers through development and application of Water-loop and Ground-coupled/Geothermal Heat Pump (WL/GCHP) Systems

- **Low-cost WLHP System Controller (SmartLoop 2000):** EPRI will support the introduction of commercial hardware in 1999.
- **Member Support Tools:** Communication products to increase knowledge of system applications and the benefits of this technology, and to encourage product infrastructure.
- **Geothermal Information Office:** This office provides information and services to all Target funders.

Increase the market penetration of energy efficient and cost effective solutions to treat ventilation air and improve indoor air quality and dehumidification

- **EPRI will develop, demonstrate, and actively support the commercialization and effective use of advanced electric solutions to treat ventilation air and meet California IAQ requirements.** These will address higher ventilation requirements due to revised American Society for Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standards.
- **EPRI will develop and demonstrate advanced electric dehumidification systems, provide objective data on**

systems performance and cost-effectiveness, and assist in commercialization and application.

Project Title: TARGET 9 COMMERCIAL BUILDING THERMAL STORAGE

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Florida State Energy Center; University of Wisconsin

Contract Amount: 1999: \$50,000
2000: \$50,000
Total: \$100,000

Match Funding: 1999: \$268,999
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Mukesh Khattar, (650) 855-2899

Commission Project Manager: Martha Brook, (916) 654-4086

Commission Contract Manager: Jane Heinz, (916) 654-4502

Project Description: The purpose of this project is to continue developing and implementing thermal energy storage (TES) technology. TES is valued for its proven capacity to trim peak power costs and reduce chiller capacity requirements, often resulting in systems more economical overall than their non-storage counterparts. This can reduce California ratepayers' electric bills and stretch California electric generation capacity. The importance of these advantages is accentuated by the emergence of refrigerant phaseout issues and real-time pricing. Many customers with facilities well suited to thermal storage are hesitant to move ahead because TES is sometimes seen as an unknown technology.

EPRI delivers the resources of two decades of thermal storage R&D to its members. Unrivaled technical and case study information, training, and applications assistance are available to the Commission and California ratepayers to facilitate selection, design, and installation of new systems. In 1999, research continues on development of easy-to-use controls for optimal system operation, new analysis methods and data to improve the use of thermal storage in conjunction with real-time pricing, and technology demonstrations to build confidence and use of the technology.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by through development and application of thermal energy

storage systems, which can reduce energy bills of California ratepayers.

Proposed Outcomes: Reduce the energy costs of California ratepayers through development, application, and commercialization of cool storage technology that is competitive with non-storage equipment in terms of efficiency and cost.

- This project includes work to improve applications design, such as methods to identify optimal thermal storage configurations to meet specific end use load and energy pricing characteristics.
- The target also includes work on controls, professional training, and infrastructure development to make thermal storage equipment easier to specify, design, install, and operate.

Project Title: TARGET 11 COMMERCIAL BUILDING LIGHTING

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; University of Wisconsin; Polytechnic University of New York; Los Alamos National Laboratory; National Institute of Standards and Technology; Lighting Research Center; BKI, Inc.; New Buildings Institute; Pacific Consulting Services; Osram-Sylvania, Inc.; Lighting Ideas, Inc.; Gough & Associates, Inc.; National Council on Quantification for Lighting Professionals; Illumination Engineering Society of North America

Contract Amount: 1999: \$ 30,000
2000: \$30,000
Total: \$60,000

Match Funding: 1999: \$204,323
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: John Kesselring, (650) 855-2902

Commission Project Manager: Gary Flamm, (916) 654-2817

Commission Contract Manager: Jane Heinz, (916) 654-4502

Project Description: The purpose of this project is to guide California ratepayers to new lighting systems that reduce their energy bills and boost worker productivity and comfort. EPRI's Lighting Information Office (LIO) provides world-class, up-to-date information on lighting technologies and cost-effective training and information services. LIO insights are captured in customer-friendly formats that the

Energy Commission can easily customize for delivery to California ratepayers. EPRI has produced an array of system design and analysis software that Commission staff can use in calculating the performance, costs, and benefits of lighting options for any customer's application. In addition, EPRI via this Target is directing collaborative research to define the relationship between lighting and productivity.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by increasing the efficiency of lighting sources with advanced light source technology.

Proposed Outcomes:

Increase the use of advanced lighting technologies through technology information.

- The Advanced Lighting Guidelines, EPRI's highly successful compendium on technology cost, performance and application, will be revised to include products released since the 1993 version.
- EPRI will create a training course that addresses the unique issues posed by new advanced lighting products. As we create new marketing and technical documents, we will add these to our web site and to our Lighting Target CD-ROM, which give the Commission staff quick access to many EPRI informational and technical resources.

Increase the use of advanced lighting technologies through analytical tools to assess lighting options.

- Analytical tools that help assess the performance and costs of lighting options to meet specific needs of California ratepayers and evaluate the benefits of these upgrades.
- EPRI will offer software support for LightPAD, the EPRI lighting audit software.

Advance the understanding of lighting benefits and accelerate the development of advanced, high-efficiency lighting products.

- EPRI will provide preliminary data and an interim report on an ongoing collaborative research program conducted by EPRI's LIO to investigate the connection between quality lighting and worker productivity.
- EPRI also is co-sponsoring research on the advanced light sources with other industry stakeholders and EPRI's Strategic Science and Technology group. This collaborative work ensures that the Commission will continue to be able to offer California ratepayers cutting-edge products that benefit from the expertise and resources of some of the world's top research organizations.

Project Title: TARGET 18 MATERIALS FABRICATION

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Terratech Corporation

Contract Amount: 1999: \$155,800
2000: \$155,800
Total: \$311,600

Match Funding: 1999: \$1,315,354
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Leo Svendsen,
(973) 263-0181

Commission Project Manager: Brian Laan,
(916) 653-7963

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to address the challenges the materials fabrication industry is facing from tightening profit margins, competition from abroad, and stricter environmental regulations. These challenges are pressuring materials fabricators to cut costs and improve productivity, quality, and efficiency to remain competitive. The materials fabrication industry is responsible for giving form to most of our modern conveniences; it makes the metal and rubber products, machinery, printing and publishing, furniture, and plastics. An enormous amount of energy goes into producing this range of goods, over 262 billion kWh per year. In addition, it is estimated that another 700 billion kWh of secondary load can be attributed to these sources within 100 miles of the primary plant(s).

EPRI's Materials Fabrication target offers technical applications, services, and communication and marketing tools that can help the materials fabrication industry meet these competitive challenges. Technologies like transverse flux heating, infrared curing, and powder coating can improve productivity, product quality, and environmental performance. In addition, EPRI's plant surveys and demonstrations provide information and innovative approaches to re-tailor traditional processes and cut costs in this competitive sector expertise with real customer solutions to real problems.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing technologies and methods to increase energy efficiency for materials fabrication industries; and
- Improving the environmental and public health costs/risks of California's electricity by providing technologies and

methods that reduce emissions of materials fabrication industrial sites.

Proposed Outcomes:

Increasing the use of infrared and ultraviolet powder coatings by providing technical information on these processes

- Develop and provide technical reports on new powder coatings that can be cured with infrared and ultraviolet light to achieve higher quality products and manufacturing that is environmentally sound
- Provide metal fabricators with superior techniques for curing materials

Increasing the use of electric infrared heating (IR) in industrial processes by providing market analyses and technical, economic, and performance information

- Deliver report on IR Market Study - Electric IR in Industrial Process Heating: A Report on Key Opportunities. Provide methods to determine likely companies to implement IR process heating.

Increasing the efficiency in the injection molding industry through technical methods to reduce energy usage

- In 1997, the injection molding industry used 17 billion pounds (7.7 billion-kg) of polymer to create a sales turnover in excess of \$46 billion. Its energy bill was 3.8 percent of turnover, or about \$1.78 billion.
- Provide an inclusive picture of energy use in the injection molding process.
- Provide information on cost-effective measures that will enable companies to reduce their energy usage without reducing the quality or the production rates of the products.
- Produce a commercial product which is cost competitive with existing dry low NOx combustors and less expensive than selective catalytic reduction (SCR), while providing emissions performance superior to both.
- For engines larger than 500 kW, Alzeta expects to manufacture a combustor that will eliminate the \$100/kW cost of additional equipment currently required for NOx mitigation.
- For engines less than 500 kW, Alzeta expects to produce combustors at costs on par with OEM combustors while maintaining low NOx performance.

Project Title: TARGET 19 MATERIALS PRODUCTION

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Carnegie

Mellon University; Edison Technology Solutions; Taratec Corporation; TU Electric

Contract Amount: 1999: \$168,000
2000 \$168,000
Total: \$336,000

Match Funding: 1999: \$1,070,022
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Leo Svendsen,
(973) 263-0181

Commission Project Manager: Brian Laan,
(916) 653-7963

Commission Contract Manager: Jane Heinz,
(916)654-4502

Project Description: The purpose of this project is to help the materials production industries have access to new, low-cost energy and energy efficient processes. Materials production industries (steel, aluminum, foundries, glass, and cement) represent the largest sector of power demand in the industrial market. These markets, important to California's future, need to have access to low-cost energy and energy efficient processes to help lower energy-related manufacturing costs and to keep these plants in California. EPRI provides access to new or existing technologies to reduce energy use and energy bills, improve productivity, lower product cost, and improve product quality. Limited resources are available to help individual plants, particularly for evaluating new electrotechnologies. The Commission can use EPRI's resources as a source of information, data, technical expertise, and tools to help California industry thrive.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity through technologies that reduce raw material waste, reduce total energy use, increase product output per unit of energy needed, and reduce the total cost of business operations; and
- Improving the environmental and public health costs/risks of California's electricity by applying technologies that reduce combustion processes, thereby lowering overall combustion emissions and reducing California's contribution to global climate change.

Proposed Outcomes:

Improving the energy efficiency of California's materials production facilities through application of new and existing technologies

- Electric Curing of Refractories Report: Test electric curing of refractories.

- Direct Resistance Heating of Steel: Investigate heating of steel billets through the use of an electric current.
- Laser Steel Cleaning - Phase II Commercial System Prototype: Evaluate the laser cleaning of steel to remove greases and light oxide coatings to reduce production costs and reduce environmental issues.
- Resistance Heating of Molten Metal in Tundish: Demonstrate that a resistance heating coil used in pouring tundish could eliminate long pouring times.
- Microwave-assisted Reduction of Iron Ore - Phase II: Determine the feasibility of using microwave technology to accelerate the necessary reactions by measuring the depth of penetration and techniques for minimizing arcing.

Increase the potential application of energy efficiency technologies through communication tools to share information with California industry regarding:

- Electric Refractory Drying in Sweden;
- Plasma Assisted Iron Production;
- Electric Arc Furnace (EAF) Productivity Improvements through use of Static VAR System;
- Improving Copper Production by using Titanium Anodes;
- Boosting Glass Production by Electric Annealing;
- Electricity Allows Unattended Sand Quarry Operation;
- Direct Resistance Heating of Steel;
- Microwave Assisted Reduction of Iron Oxide Phase II; and
- Industrial News Today: Monthly briefing summarizing new and ongoing products/services across all targets

Project Title: TARGET 27 ELECTRONICS INDUSTRY

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; J&M Associates; Alzeta; International Sematech; J&M Associates; Sematech, Inc

Contract Amount: 1999: \$100,000
2000: \$100,000
Total: \$200,000

Match Funding: 1999: \$551,868
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: William M. Smith, (650) 855-2415

Commission Project Manager: Clint Lowell, (916) 654-4554, Ben Mehta, 654-4044

Commission Contract Manager: Jane Heinz, (916) 654-4502

Project Description: The purpose of this project is to address the major energy, productivity and environmental issues of the expanding California electronics industry. Industries in this rapidly growing market sector—including manufacturers of semiconductors, printed wiring boards, telecommunications equipment, computers, and peripherals (all major California industries)—face these issues as they strive to sustain or expand their position in the global marketplace. Yield, equipment utilization, energy efficiency, power quality, and water management are essential issues that all California electronics manufacturers must address. In addition, many firms in this internationally competitive industry strive to keep their product development efforts highly confidential.

EPRI's Electronics Industry Target follows a twofold strategy in working with these proprietary-minded industry sectors. The initial step in engaging any electronics industry sector involves the creation of an "industry gateway" through the formation of strategic alliances and project partnerships with industry organizations, through which project proposals may be credibly prioritized. The second step entails developing leveraged projects that create products of mutual interest to the industry sector(s) involved and the target funders. Such leverage may come in the form of supplemental funding from target funders or access to industry funded project results that only target funders can obtain. This strategy increases the likelihood that the project results will be used by the industry sector(s) that can benefit from those results, as the industry gateway approach permits a continuing connection to industry, even after a specific project has been completed.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by promoting energy efficient manufacturing tools and processes, including manufacturing facility operations. The target also promotes electrotechnology applications (e.g., for water management) that result in the minimum use of electricity per unit of product, while maximizing the value of electricity by reducing overall production costs; and
- Improving the environmental and public health costs/risks of California's electricity by engaging in research to improve air, water, and solids emissions through pollution prevention, in-plant recycling, and end-of-pipe mechanisms in electronics plants.

Proposed Outcomes:

Accelerate the development and market penetration of energy- and water-efficient technologies to make productivity

and environmental gains in California electronics manufacturing.

- Working through existing and new national-level industry gateways (e.g., SEMI/SEMATECH, IPC, the Industrial Technology Research Institute (ITRI), Semiconductor Manufacturing Technology (SEMATECH), and the National Electronics Manufacturing Initiative (NEMI), establish a networked infrastructure with California industry (e.g., through organizations and associations like the California Manufacturer's Association (CMA) and the Major energy User's Group (MEUG).
- Employ this California network to initiate development and demonstration projects that gain national endorsement by target funders.
- Likewise, engage this California network as a facilitator of technology deployment for project results developed outside the State (e.g., 1998 semiconductor project results, 1999 printed wiring board and semiconductor project results).
- Provide a complete EPRI solution for any California electronics manufacturer by coordinating efforts with other EPRI target areas (e.g., power quality).

Compile and disseminate up-to-date information on electronics industry market conditions, primary issues, available technologies for addressing these issues, and industry research progress and needs.

- Assess the impacts of world market conditions on the national and California electronics industry, with regard to how well they can compete globally and how energy- and water-efficient technologies can address their needs.
- Provide the results of these assessments through newsletters (e.g., Industrial News Today) and meeting forums (e.g., Electronics Industry Target Advisory Council).

Project Title: TARGET 28 AIRPORT SOLUTIONS

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Hawaiian Electric Company Inc; CAREY Transportation; Henry C. Larry

Contract Amount: 1999: \$80,000
2000: \$80,000
Total: \$160,000

Match Funding: 1999: \$151,045
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Layla Sandell,
(650) 855-2756

Commission Project Manager: Mark Rawson,
(916) 654-4671

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to develop new environmental and energy technologies and apply existing technologies, such as electric vehicles, to airport infrastructure to reduce pollution and subsequent costs. In addition, the project will develop improvements to airport efficiency, productivity and safety. Commercial airports are microcosms of all sectors of the electricity marketplace, are major energy users, and are of vital importance to the economic health of their surrounding community. The contribution to local and regional economies from California's largest airports is hundred of millions dollars every year. However, airports face new and ongoing challenges. Citizens in surrounding communities question the impacts of airports on their quality of life. Reducing overall pollutant emissions from airport facilities has become a high priority issue. These issues could limit airport growth and in turn impact local and regional economies.

Converting ground transportation and other airport equipment to electricity is one solution to these issues. Inside terminals, the installation of electrically powered equipment can improve indoor air quality, reduce HVAC system operating costs, and prevent disruptions in power quality-sensitive equipment. Outside terminals, the use of electrified equipment and vehicles can provide annual operating cost savings exceeding \$500,000. In addition, emission reductions of up to 80 percent could be expected at airports that convert much of their ground transportation and equipment to electricity. EPRI's Airport Solutions Target has developed the necessary methodologies and models to assess the feasibility of electrification and the associated economic and environmental benefits on an airport-specific basis. Through the development and deployment of electrotechnologies, sustainable growth of airports will be enhanced, and energy savings will be attained.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing information on efficiency improvements available for use by airports; and
- Improving the environmental and public health costs/risks of California's electricity by reducing emissions from the internal combustion engines used by airport facilities by replacing them with electrically-powered equipment.

Proposed Outcomes:

Providing information on energy solutions to support the improvement and growth of California airports.

- Electric Vehicle and Ground Support Equipment (GSE) Demonstration: EPRI is conducting a major project with the Detroit Metropolitan Airport, American Airlines, and Detroit Edison to convert ground support equipment to electric equipment. The performance of several types of EVs will be monitored for multiple parameters under various weather and operating conditions. The performance data will be assessed to determine adherence to vendor specifications and confirm economic and technical viability and environmental benefits.
- This project is the third part of an effort begun in 1997. In part one, several airport-specific assessments were conducted around the country that determined the technological feasibility and economic and environmental impacts of internal combustion vehicle electrification. In part two, charging station specifications were developed and installed. The results of these efforts will be provided.
- EPRI Electric Ground Support Equipment GSE Market Penetration Issues Round Table: This meeting was attended by multiple players in the airport industry. Results of the round table will provide insights into the penetration issues in California. The proceedings are available.

Project Title: TARGET 35 CUSTOMER POWER CONDITIONING SOLUTIONS

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Power Electronics Applications Center; Adjustable Speed Drive Demonstration Office Maxwell Technology (CA); Trinity Flywheel Corp. (CA); DCH Technology (CA); Pillar Flywheel Co.; Active Power; Electrotech; (CA); Urenco (England); Oregon State University; Precise Power Corp; Teco-Westinghouse; University of Texas, Austin; Power Cell Co.

Contract Amount: 1999: \$426,563
2000: \$426,563
Total: \$853,126

Match Funding: 1999: \$1,416,014
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Ben Banerjee,
(650) 855-7925

Commission Project Manager: Brian Laan,
(916) 654-7963

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to address the power quality (PQ) issues facing commercial and industrial energy users who are using devices that are more sensitive to PQ variations. Sensitive loads often are in extensive networks and automated processes, and many larger loads use power electronics for power conversion. These new, technology-driven changes have created a growing concern in many California businesses about the quality of power and its potential negative impact on productivity, downtime costs, and lost product. These concerns focus on power quality mitigation equipment, that is, power conditioning equipment that can protect loads from PQ variations.

EPRI research efforts have identified voltage sags and momentary interruptions as the two most important categories of California's power quality variations affecting end users. Traditional power quality mitigation technologies such as uninterruptible power supply (UPS) systems can effectively address these problems, but at a substantial cost. EPRI's Target 35 provides information about the best and most cost-effective power conditioning equipment available, and the technical expertise to help California ratepayers use the equipment properly. This target provides information on power conditioning issues, along with guidance on the proper selection, application, and installation of power conditioning equipment. It also identifies and demonstrates new and innovative technologies with high commercialization potential such as Advanced Flywheels, Advanced Voltage Regulator/UPS and Line Fault Protector, and Voltage Sag Ride-Through Devices.

State-of-the-art power electronics provide higher-performing solutions, integrating voltage regulation for entire customer loads, and UPS for a defined priority load. Built-in load management allows customers to prioritize loads to keep all loads supported through voltage sag and critical loads supported through an extended outage. The price point is very attractive when compared to existing UPS or voltage regulator systems. Using an advanced voltage regulator/UPS and line fault protector to power equipment through voltage sags and momentary interruptions could eliminate California industry and ratepayer power quality interruptions.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by providing knowledge to California ratepayers about how to mitigate power quality problems that cause equipment failure.

Proposed Outcomes:

Provide California ratepayers the opportunity to apply the advanced flywheel, a cost-effective energy storage technology, to ride through power quality events.

- As energy storage technologies, advanced flywheels show great commercial promise for providing short-term backup in riding through sags and momentary interruptions, and at a cost that is potentially much lower than conventional backup systems. In this product, the Commission receives information essential for the proper selection, application, and installation of advanced flywheels in end-use customer facilities.

Provide California ratepayers the opportunity to apply the supercapacitor, a cost-effective energy storage technology, to ride through power quality events.

- Like advanced flywheels, supercapacitors show great commercial potential for cost-effective short-term ride-through of sags and momentary interruptions. Using power quality mitigation equipment to power end-use equipment through voltage sags and momentary interruptions could eliminate a majority of process and equipment interruptions, benefiting California ratepayers and businesses in all end-use market segments.

Provide California ratepayers the opportunity to apply the advanced voltage regulator/UPS and line fault protector, cost-effective energy storage technologies, to ride through power quality events.

- Ride-through equipment is more cost-effective than conventional back-up systems for many customers, but the choice of commercial equipment for this purpose is limited. By working with equipment developers at an early stage, the Commission can accelerate commercialization and help ensure that the first commercial products are well targeted to meet California industry and ratepayer needs.

Reduce the cost of power conditioning.

- Cost Analysis and Reduction of Power Quality Mitigation Hardware. Reducing the cost of power conditioning will benefit all California end-users. This product explores the cost components of power quality mitigation equipment installations and identifies ways in which the total cost can be reduced. Emphasis is placed on examining life-cycle costs for power conditioning solutions and developing a methodology for accurately estimating life-cycle costs for solution options. Based on this methodology, a preliminary functional specification for a software application will be developed for possible incorporation into the EPRI Power Quality Database.

Project Title: TARGET 38 POWER QUALITY FOR IMPROVED INDUSTRIAL OPERATIONS

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Duke Energy Corporation; Electrotek Concepts, Inc; EPRI PEAC Corporation; Global Software Resources, Inc.; Jacobs Engineering Group, Inc.

Contract Amount: 1999: \$426,563
2000: \$426,563

Total Contract: \$853,126

Match Funding: 1999: \$1,273,975
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Sid Bhatt, (650) 855-8751

Commission Project Manager: Brian Laan, (916) 654-7963

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to address problems of power quality for the modern, highly automated industrial plants in California that suffer from breakdowns and lost productivity due to voltage, current, or frequency variations within the plant. Power quality (PQ) problems on the utility lines or within an industrial plant can cause equipment failure; damaged products; unsafe working conditions; and wasted time, material, and labor. With today's global competition and increasingly sophisticated and computer-controlled manufacturing processes, industries demand a reliable source of electricity. Energy companies and customers alike need up-to-date information, technology, and training if both are to remain competitive.

This target offers a complete package of data, information, and knowledge addressing power quality concerns at industrial plants. EPRI products are designed to reduce analysis and engineering time, labor costs, and investigation expenses. Information and training programs serve to educate utility and industrial customer power quality personnel on how to avoid power quality problems by characterizing specific systems. Economic analysis of solution options allows California industry to select the right solution for the PQ problem at hand at the right cost.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by helping California industry more quickly identify the causes of power quality problems, understand the various options for solutions and costs of implementation, and then select the option that best fits the need; and

- Improving the energy cost/value of California's electricity by reducing the impacts of power quality problems by providing cost-effective and fast solutions.

Proposed Outcomes:

Minimize the impacts of power quality problems on industrial energy customers by providing experiential data on past power quality problems and solutions.

- Provide an easy-to-use reference book so that known successes can be repeatedly applied by California's industrial plant personnel. These benefits allow California industry to reduce costs associated with power quality investigations, reduce equipment misoperation costs due to power quality aberrations, and improve plant operations.
- Provide Power Quality Workbook for Industrial Processes. This workbook explains for industrial customers the reasons for power quality recommendations and how to avoid power quality problems in future installations, thus saving industrial customers time and money.
- Provide guidebooks which give insights learned in prior EPRI demonstration power quality projects and product evaluations. This product draws on an extensive base of experience over nearly a decade of in-the-field experience with diagnosis and resolution of manufacturing equipment power quality problems. The Commission can use the guidebooks to identify opportunities for utilizing proven solutions to benefit California's industrial sector.

Provide industrial sector power quality information services and support to help California industry reduce the costs associated with trouble-shooting power quality problems, enhance the Energy Commission's industrial relations and ratepayer satisfaction, and develop cost-effective power quality solutions.

- Electronic and printed publications—including case studies, brochures, technical briefs, newsletters, and guidelines—are distributed on a monthly basis. Emphasis is on expanding the amount of up-to-the-minute technical and marketing information available via a web site offered only to target participants
- The Energy Commission receives exclusive access to the PEAC toll-free hotline for technical assistance and opportunities to consult PEAC experts for troubleshooting and site visits. PEAC training courses are also available to California industry.
- Workshops, Power Quality Applications (PQA) conferences, and the Power Quality Interest Group (PQIG) bring together national and international experts, creating

forums for sharing late-breaking technical and marketing developments with the Commission and serving to open dialogue between the Commission and California industry. Information supports critical standards development activities to bring funders, industrial end-users, and equipment manufacturers together for technical discourse and to establish directions and performance targets for the next generations of end-use electrical equipment.

Provide a Power Quality Solution Package-Integrated Voltage Sag to help understand more efficient power quality diagnoses and how to implement cost-effective, timely solutions for California industry. These capabilities allow California industry to reduce costs, and improve overall power supply reliability. End-use customer benefits include improved productivity, reduced downtime, reduced costs, and more efficient use of manufacturing resources.

- This product combines new EPRI research with the results of preceding efforts to provide a universal voltage sag solution package. It is a complete package of tools for the assessment and resolution of voltage sag problems in manufacturing settings.

Focus power quality improvement efforts, resources, and services more effectively for specific industries.

- This product includes packages featuring power quality application guidelines and evaluation tools for specific manufacturing industry segments.

Evaluation of retrofit capabilities for hardening drives/process equipment will increase the immunity of industrial customers to voltage sags and interruptions.

- Market and Technology Assessment for the Integration of Cost-effective Embedded Power Quality Solutions for Industrial End-use Equipment: Describes the range of potential cost-effective embedded power quality solutions for industrial equipment with the range of improvement weighed against the risks of increased.

Field demonstrations of power quality mitigation technologies at industrial customer sites will increase application understanding and build customer confidence in the technologies.

- A preliminary analysis and site screening, start-up project management assistance, and initial design (Phase I) of planned demonstrations are provided through this project. Additional efforts required for individual demonstrations—detailed design, equipment procurement and installation, commissioning, monitoring, data collection, and analysis—are funded by participants through TC and other mechanisms.

Coordination of Industry-based Power Quality Standards (Industrial) will lead to industrial power systems and equipment that are designed and operated to be compatible with the expected electrical environment, thus reducing costs and other impacts of power quality problems.

- Supported by the EPRI PEAC Power Quality Test Facility (PQTF), this product provides the Commission with a coordinated effort to interface with, learn about and influence power quality-related standards coming from industrial customer groups such as the National Electrical Manufacturers Association (NEMA) Motors and Drives Committee, Computer Numerical Control (CNC) Machine Tool Manufacturers, Semiconductor Equipment and Materials International (SEMI), Tool Standards Organization, Factory Controls and Automations groups, and others.

Project Title: TARGET 41 OPPORTUNITIES IN NETWORKED HOME SERVICES

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Paragon Consulting (CA); EH Publishing; Levey Associates (CA); Connect USA, Huffman Publications (CA); Macro Research (CA); Web Wizard (CA); Centermore Group, Collaborative.com (CA); North-Atlantic Consulting; Phillips; Sony; WebTV; Meternet.

Contract Amount: 1999: \$315,000
2000: \$315,000

Total Contract: \$630,000

Match Funding: 1999: \$741,045
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Craig McAllister,
(650) 855-1095

Commission Project Manager: Tom Tanton,
(916) 654-4515

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to help California ratepayers with telecommunication-based consumer electronics and Internet-based service opportunities related to energy usage, Internet billing, meter reading, appliance control, and energy information. California ratepayers need help to sort through the many choices, find current, accurate information and analyses and perspectives sensitive to energy issues - online, interactive and customized to their needs. This Target is designed to provide California ratepayers with these resources. This Target offers convenient and relevant technology surveillance services, coupled with interactive

web-based access to specialists and experts inside and outside the utility industry.

Focus- and custom- EPRI analysis is provided in several key areas:

- Protocols and technical standards, converging technologies, and commercial activity in powerline, telephone, radio frequency (RF) and cable media;
- Products and vendors of commercially available systems, including integration and management services;
- Projects, market assessments, and economic analysis.

EPRI supports implementation of practical solutions in several ways:

- Builder guidelines for new home networking (expanding on the growing service offering begun with HVAC and heat pump guidelines);
- Mobile and Internet connected networked home showcases;
- Energy Network Computer Information Network systems deployment projects.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by informing California energy users of new technologies and services to minimize use and cost of electricity and maximize value to the residential ratepayers.

Proposed Outcomes:

Provide market, technology, and business analyses to increase the potential of success of new products and services.

- The Energy Commission will be kept abreast of the latest developments in advanced information and communications technology for the mass market and how these can be used to develop new products and services.
- The convergence and potential integration of new technologies from the security, entertainment, communications, community information, Internet, residential energy management, and electronic commerce industries will be assessed.
- The value of convergent TV, cable, and computer technologies will also be investigated. Realistic estimates of commercial introduction dates and prices of new technologies will be made.

Provide Networked Home Centers test-bed facilities to increase likelihood of adoption in California. EPRICSG will build two different classes of test-bed facilities to assist component manufacturers, system integrators, appliance manufacturers and home builders in satisfying California residents.

- A Networked Home Development Laboratory will be built to focus on the technical aspects of designing and managing the very large-scale systems needed to deliver mass market information services and products. The laboratory will provide a standards-based environment where new applications, integration techniques, hardware, and software can be tested and verified under realistic simulated large-load conditions. Target customers will be able to nominate solutions for testing. Results will be delivered over the web and in workshops held at the laboratory.
- One or more Networked Home Showcase Centers will be built with target customers to exhibit the integration of the latest advanced technology for Networked Homes in areas such as entertainment, home information management, home security, personal safety systems, energy management systems, remote education, health management, local commerce, and neighborhood communications. Corporate partners will be recruited to provide major computer, communications, and entertainment systems. Consumer preferences will be tested in the centers, and the various regional centers will be linked via the Internet to examine consumer demographic preferences.

Provide market, technology, and business analyses on Smart Appliances to bring benefits to California ratepayers.

- These new appliances will reduce energy use through improved energy management systems and report operational problems to service providers over the Internet. California ratepayers will benefit from improved load shapes and their associated costs and from energy savings when they modify behavior based on knowledge of individual load use reported on itemized invoices and from monitored appliances.
- Work will include technical specifications, design concepts, market research, and business analyses. Field tests of prototypes will be performed in TC and cofunded projects. A Smart Appliances Task Force comprised of energy companies, appliance and control system manufacturers, home builders and government agencies will be convened to help jump-start the market.

Project Title: TARGET 49 POWER MARKETS AND RISK MANAGEMENT

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; The Brattle Group; L.R. Christensen and Associates; The Northbridge Group; Bechtel Group, Inc.; Energoprojekt Consulting SA; Laurits R Christensen Associates Inc; M.S. Gerber &

Associates; Marketing Decision Research, Inc; Pattern Recognition Technologies; Strategic Decisions Group

Contract Amount: 1999: \$400,000

2000: \$400,000

Total Contract: \$800,000

Match Funding: 1999: \$3,336,827

2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Art Altma,
(650) 855-8740

Commission Project Manager: Richard Grix,
(916) 645-4859

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to provide a means of understanding risk in the California energy market. Managing risk is a key to competitive electricity prices in California, but traditional analyses cannot accurately reflect the value of resources or risks in today's market. EPRI provides a unique and powerful framework—anchored in modern finance theory—for making decisions with less risk, avoiding huge losses and providing a more stable electricity price environment. EPRI's Electricity Book and other EPRI products extend this tool, and focus on other critical issues, such as forward price curves and ancillary markets. Classes, workshops, and interest groups help Commission staff use all of EPRI's risk management tools quickly and effectively.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by reducing the risk associated with large electricity transactions and providing a more stable California electricity market.

Proposed Outcomes:

Provide a comprehensive analysis tool to model the California electricity market and the risks associated with the market.

- Deliver EPRI's Electricity Book software, which provides a framework for calculating value and managing risk. The book provides a method for estimating the value of specific physical assets or contracts and provides a framework for understanding, measuring, and managing the risks of a portfolio of assets, contracts, and customers.
- The Electricity Book will greatly decrease the time and cost of the Energy Commission's valuation activities, while helping develop an integrated perspective on managing risk in California. As a result, the Commission can identify profitable transactions and define hedging strategies that

reduce risks estimating what action wholesale traders are likely to take and potential effects on California electricity prices.

Provide tools to value the benefits and risks of energy market transactions.

- EPRI has developed an array of specialized methods for valuing the benefits and risks of energy market transactions that reflect the latest knowledge about market contracts. Many of these methods have been incorporated into the Electricity Book software and into the PowerCoach family of tools.
- EPRI will deliver PowerCoach Lite, an Excel-based software program that lets one evaluate power transaction decisions in light of potential profits and risks, while considering foregone spot market opportunities.
- EPRI will deliver the Options Evaluator software that helps companies quickly estimate profitability and uncertainty ranges in power options, a financial instrument that is seeing increased use in energy markets.
- EPRI will conduct case studies to improve the fuels component of the Electricity Book software, which can help the Commission better understand how California electricity providers manage their exposure to changing fuel prices by establishing a hedging program that balances risks against profitability.

Provide Better Forward Curve Estimates to Improve Energy Users Decision Making

- This product provides a suite of methods, training, and tools to estimate forward curve price levels, volatilities and cross correlations.

Provide Better Understanding of Ancillary Services

- For most market participants, costing and profitable pricing of such ancillary services as load following, spinning reserves, and frequency control remains an uncertain proposition. Drawing on previous work, EPRI in 1998 developed research-grade spreadsheet tools to help the Commission understand the cost of providing reserves from generating units, calculate the use of reserves by retail and wholesale customers, and understand likely pricing strategies.

Project Title: TARGETS 63.0 EMERGING DISTRIBUTED RESOURCE TECHNOLOGIES; 63.1 IC ENGINE DEVELOPMENT FOR DR APPLICATIONS; 63.4 FUEL CELL DISTRIBUTED POWER SYSTEMS

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Power Computing Systems; Proton Energy Systems; Hpower; American Fuel Cell Corporation; NYSEG; International Fuel Cell; TMI; MSRI; SCE; Chugach Electric Assoc.; SDG&E; American Electric Power.

Contract Amount: 1999: \$224,250
2000: \$224,250

Total Contract: \$448,500

Match Funding: 1999 \$3,796,885
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Dan Rastler,
(650) 855-2521

Commission Project Manager: Jairam Gopal,
(916) 654-4880

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to promote the potential that distributed resources (DR) have to provide a substantial portion of the energy alternatives now demanded by California electricity users. Both energy service providers and customers need accurate and unbiased information on the benefits and liabilities associated with commercially available and emerging distributed resource technologies. DR technologies offer third-party energy service providers and energy customers innovative solutions to their energy service needs. EPRI's Emerging DR technologies target provides detailed information on commercially mature reciprocating engines and gas turbines, and emerging microturbines and fuel cell systems technologies. To gather this information, EPRI assesses advanced DR components, performs technology validations, and leads pre-commercial development on technologies that offer high pay-off. As a member, the Energy Commission will obtain intelligence in three distinct areas: 1) rapid changes in technology, 2) development of new distributed resources, and 3) post-R&D commercialization initiatives. This target examines a balanced portfolio of near-, intermediate-, and long-term options.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by developing generation options that energy providers can utilize to provide unique solutions for peaking power issues, to enhance system reliability (system voltage control), and to assure power quality to their customers;
- Improving the energy cost/value of California's electricity by assisting in the development of innovative distributed resource technologies that can potentially provide lower delivered cost electricity than central station power; and

- Improving the environmental and public health costs/risks of California's electricity by assisting in developing fuel cell systems and other environmentally preferred generation technologies to replace traditional central station power.

Proposed Outcomes:

Increase customer choice and enable competition by providing unbiased accurate information on emerging DR technologies.

- Accurate, reliable information on breakthrough DR technologies will be gathered to assist direct business planning, infrastructure investment and technical improvements. The information is drawn from EPRI global contacts to identify and synthesize information on emerging distributed generation technologies that are within 2-5 years of deployment in industrial, commercial, and residential market applications.
- Information will be made available through an assessment report, newsletters, vendor technology forums, vendor workshops, and specialized in-house briefings.

Speed the commercialization and advancement of DR technologies by providing information and assistance toward the resolution of cross cutting issues that generally slow the adoption process.

Cross cutting issues addressed, evaluated, and documented include the following:

- Gas-Based DR Fuel Pressure and Delivery Issues
- Recuperators/Regenerators for Microturbines and Industrial Gas Turbines
- Emission Control Technologies for Distributed Generation Options
- Hydrocarbon Reformers for Fuel Cell Systems

Bringing to market readiness fuel cell technologies that include polymer electrolyte membrane (PEM) fuel cell systems and ultra-high efficient solid-oxide fuel cells (SOFC).

- Target efforts will build upon 1998 results that assessed PEM 50 kW on-site energy systems and 3 kW residential systems for remote power and telecommunication market. Tests will be performed on these sizes and applications.
- Test results from a 100 kW Solid Oxide Fuel Cell (SOFC) HVAC system will be used to further its development. Results include test results, development status, as well as technological, economic and market advantages of this technology and application.
- Test will be performed on a 250 kW Planar SOFC-CT Ultra-High Efficiency System. The test will evaluate performance and system dynamics to validate the design.

Accelerate the development of spark-ignited and micro-pilot, dual-fuel natural gas engines with major engine manufacturers for commercial applications in the 600 kW to 2 MW size range.

- Reduce the capital investment required to convert diesel machines to gas fired. Tests will evaluate the performance and emissions of two machines when firing natural gas rather than diesel oil.
- Develop a retrofit system that will ultimately address conversions of natural gas engines to dual-fuel operation, covering the size range of 300kW to greater than 1 MW. This multiyear development effort will result in the availability of two commercial engines and a retrofit system for diesel-to-natural gas conversions.

Project Title: TARGET 66 RENEWABLE TECHNOLOGY OPTIONS AND GREEN POWER

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Augenstein Dba Iem D; Holt Edward A; Karen Conover; Morabito, Dr. J.M.; Morton, Thomas; Nierenberg, Ron; Rla Consulting; Taylor Patricia Weis; Wind Economics & Tec; Ascension Technology; Cedar Falls Utilities; Central & South West Services, Inc.; City Of Brownfield; Cummins Power Generation, Inc; Fortum Power And Heat; Foster Wheeler Development Corp; Green Mountain Power Company; Kansas Electric Utilities Research Program; Nebraska Public Power District; Nevada Power; New York State Electric And Gas; Pennsylvania State University; Princeton University; Resolve, Inc.; Riso National Laboratory; Southern Research Institute; Tennessee Valley Authority; University Of Delaware; University Of Illinois At Urbana; University Of South Florida; University Of Texas At Austin; York Research Corporation.

Contract Amount: 1999: \$412,000
2000: \$412,000

Total Contract: \$ 824,000

Match Funding: 1999: \$1,790,212
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Dan Rastler,
(650) 855-2521

Commission Project Manager: Michelle Pantoya,
(916) 653-4128

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to address the barriers renewable energy technologies face in spite of customer enthusiasm, technology advances, and

dropping prices. Still needed are standardized technology and control protocols, more efficient operating strategies, and broader definitions of the true benefits of renewable energy. This EPRI target packages objective information and real-world experience focusing on three main options—wind power, photovoltaics, and biomass. Specifically, EPRI will manage California's wind energy forecasting project, and broker other collaborative projects with utilities, DOE and others. EPRI will deliver results in areas including biomass cofiring with natural gas, wind power, a renewable energy technical assessment guide, and PV interconnections. This EPRI target provides information on renewable technology performance and costs, analyzes the energy and non-energy benefits of deploying renewable technologies, and offers an inside look at the working experiences of companies around the world.

This project supports the PIER Program objectives of:

- Improving the environmental and public health costs/risks of California's electricity by increasing the potential for application of renewables by providing accurate information on performance, energy and non-energy benefits, costs, and best practices; and
- Improving the reliability/quality of California's electricity by facilitating the integration of electricity from distributed generation technologies into the State's electricity transmission and distribution system.

Proposed Outcomes:

Increase the potential for application of wind power by providing accurate information to California electricity customers and energy developers by:

- Documenting wind power technology and costs, deployment issues and solutions, and methods for improving wind turbine performance and wind energy output forecasting.
- Providing guidelines on wind project design and implementation, from design, siting, and permitting through construction, acceptance, and optimization.
- Documenting others' experience to select the best options, avoid costly errors, and improve performance and asset management in wind power applications.

Reduce the financial risk for wind generators to bid to supply real-time and next-day wind energy and ancillary benefits to the California Independent System Operator (ISO), Power Exchange (PX), and Automated Power Exchange (APX) by:

- Developing a California Wind Energy Forecasting System to generate two or more daily forecasts of the hourly wind generation over the next 48 hours for each of the wind generation areas in the State.

Increase the potential for application of photovoltaics in California by providing accurate information on the technology, the markets, and issues by:

- Assessing current and future technologies, markets, and best practices for interconnection with the grid.
- Screen technologies, develop interconnection procedures and design of market introduction strategies.
- Developing strategies for deploying PV programs that attract customers; ensure smooth customer experience with dependable interconnectivity procedures.

Increase the use of waste in California for energy production through biopower applications by:

- Analyzing worldwide biomass experience to elucidate technical, economic, and environmental issues and opportunities, with special focus on coproduction and cofiring.
- Documenting biomass opportunities and benefits assessment, designing biomass projects, and environmental compliance.
- Providing in-depth market, fuel, and technical knowledge to smoothly implement biomass programs that offer maximum benefits.

Project Title: TARGETS: 87.0 HYDROPOWER OPERATIONS, RELICENSING AND ENVIRONMENTAL ISSUES; 87.1 ENVIRONMENTAL ISSUES MANAGEMENT

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; B.C. Hydro International Ltd.; HCI Publications; Iris Power Engineering Inc; Kearns & West Inc; EA Engineering; Science & Technology Inc; Lang, Railsback & Associates; Lockheed Martin Energy Research Corp

Contract Amount: 1999: \$ 89,250

2000: \$89,250

Total Contract: \$178,500

Match Funding: 1999: \$826,738

2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Norris Hirota,
(650) 855-2084

Commission Project Manager: Linda Spiegel,
(916) 654-5061

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to address the challenges facing the hydroelectric industry that come in the areas of Federal Energy Regulatory Commission (FERC) relicensing and environmental mitigation. Balancing the protection of fish and wildlife resources with multiple demands for water use can be optimized by utilizing credible scientific information, tools, and methods. The management of hydro project decommissioning, including impoundment sediment management (characterization, removal, and disposal), dam removal, and ecosystem restoration are complex technical issues for which little background science exists. This EPRI tiered target offers cost-effective solutions to address critical relicensing, environmental, and public issues related to the hydro industry, by utilizing the world-renowned expertise of EPRI scientists and engineers, forums for sharing information and capitalizing on the lessons learned by others, and leveraged development of solutions to common problems.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by compiling expert knowledge on the best practices for optimizing hydro plant operations and performance to enhance grid reliability;
- Improving the energy cost/value of California's electricity by helping to minimize the cost of hydropower while protecting the environment; and
- Improving the environmental costs/risks of California's electricity by providing expert knowledge on addressing multi-stakeholder relicensing issues and by studying how best to manage entire watersheds containing hydroelectric development, rather than managing hydro projects individually.

Proposed Outcomes:

Improve the relicensing process to achieve results acceptable to all stakeholders at minimum cost to stakeholders by providing information on relicensing best practices for the hydropower industry.

- Information resources to help the hydro industry improve management of operational, environmental, and public issues, particularly during relicensing.
- Best Practices Guidebook for the hydropower industry.
- Technical report on additional preferred practices.
- Updated Best Practices Guide.
- A web site dedicated to providing the latest, real-time information on hydropower research and relicensing, with links to other web sites.

Reduce the cost of operating hydropower while protecting the environment by providing information on worldwide technological developments relevant to the hydropower business.

- EPRI's Hydro Round-Up Reports, delivered semi-annually, describe successful worldwide technological, operational, and management approaches to solving pressing hydro problems and realizing cost savings while protecting the environment.

Improve fish protection methods by providing scientific information, techniques, and guidance based on state-of-the-art and emerging methods for instream flow management.

- EPRI Technical Report and peer-reviewed literature on application of compensation mechanisms (CompMech) in fish populations to instream flow needs model.
- EPRI technical report on review of instream flow methods and evaluation of the effectiveness of instream flow predictions.

Decrease fish mortality by providing assessment methods for more accurately evaluating the effects of turbine entrainment and mortality on fish populations.

- EPRI technical report and peer-reviewed literature on the CompMech family of individual fish-based models, focusing on importance of life history strategies and stage-specific entrainment impacts.
- EPRI technical report on the analysis of population and ecosystem level entrainment effects, building upon EPRI's family of RAMAS models for ecological risk analysis.

Provide information and tools for determining cost-effective upstream and downstream fish passage and protection needs for migratory and nonmigratory fish.

- International conference/workshop and issuing peer-reviewed book on catadromous eels. Methodology applies to other fish and systems.
- EPRI technical report on review on the effectiveness of fish passage facilities and fish protection devices.

Improve water resources management for optimized power production while complying with environmental protection requirements.

- EPRI technical report, peer-reviewed literature, and research-grade software (Decision Support System) on hydrobasin management to provide a tool and a process for using disparate stakeholder values when planning hydroelectric operations and facilities development.

Offer a cost-effective approach for site-specific environmental data gathering and ecosystem research needs while providing future communication links with the environmental management, regulatory, and research community.

- Support Graduate Research Fellowships in Ecology and Hydrology.

Project Title: TARGET 91 AIR TOXICS HEALTH AND RISK ASSESSMENT

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Atmospheric & Environmental Research Inc; Exponent Failure Analysis Associates; Golder Associates Inc; ICF Kaiser Engineers; Lockheed Martin Energy Systems Inc; Raptor Research Project; SCOPE; Tetra Tech Inc; University of Connecticut; University of Maryland; University of Nevada, Reno; University Of Rochester; Wisconsin Department of Natural Resources.

Contract Amount: 1999: \$480,000
2000: \$480,00

Total Contract: \$960,000

Match Funding: 1999: \$3,233,763
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Leonard Levin,
(650) 855-7929

Commission Project Manager: Obed Odoebelam,
(916) 654-4171

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to determine whether trace substances emitted by power plants may be deposited near the emissions sources or be transported over great distances. At issue is whether power plant contributions pose concerns for human health and environmental quality. Currently, air toxics such as dioxins, arsenic, nickel, and especially mercury are of growing regulatory, public, and economic concern. Recent U.S. EPA reports to Congress address the relationship between these toxics and power plant emissions, and call for extensive research into several key questions: How toxic is the material emitted by power plants? To what extent, and by what means, are people exposed to that material? How can a realistic estimate of quantitative risk be derived? What risks are significant? Basic scientific understanding of these issues is critical to the energy industry.

The primary focus of this EPRI target is filling gaps in scientific and health information. EPRI research is designed to inform energy companies and policy-makers of the health and environmental basis for potential risks associated with air emissions and, when appropriate, to examine practical management solutions. This target, combined with the other EPRI research on air toxics measurement and control, provides a total integrated response to the issues cited above. EPRI's comprehensive risk-assessment framework has also been critical in supporting informed and cost-effective community health decisions. By providing objective and timely information, EPRI promotes science-based decision making on air toxics.

This project supports the PIER Program objectives of:

- Improving the environmental and public health costs/risks of California's electricity by providing science-based assessment of air toxics health and risk impacts; and
- Improving the safety of California's electricity by assessing the risk of power generation with regard to air toxics, by providing science-based assessment of air toxics health and risk impacts.

Proposed Outcomes:

Providing advanced tools and data to evaluate public exposure to mercury and other substances, including dioxins, with significant non-inhalation exposure routes.

- Assessing human exposure to mercury and other substances at both community and national levels, using the Total Risk of Utility Emissions (TRUE) model and comparing to emerging data sets.
- Defining realistic exposure characteristics of sensitive subpopulations, employing quantified loadings to ecosystems with which human populations interact.
- Updating food consumption and other exposure information, applicable to a wide variety of site-specific settings.
- Refining human neurotoxicity testing methods for realistically evaluating health effects of mercury exposure.

Quantifying atmospheric mercury concentrations and deposition in time and space to establish local versus regional/global influence.

- Determining the temporal and spatial nature of atmospheric mercury concentration and deposition. Monitoring stations include one in California.
- Conducting a workshop of international experts to critically review and integrate the results of historical mercury deposition studies and to foster information exchange and research collaboration.

- Developing and continually updating and analyzing databases for North American and global atmospheric mercury.
- Assessing the relative importance of local, regional, and global mercury sources for various regimes.

Evaluating natural mercury emissions to provide a more accurate context for perspectives on power plant mercury emissions.

- Determining methods for measuring natural and background mercury emissions.
- Improving the accuracy of overall mercury emissions inventory, as natural source components can be based on actual field measurements rather than being inferred from mass balance arguments.
- Establishing a temporal and geographic range of monitoring sites that will provide insight into the variability of emissions.

Determining source-receptor relationships for air toxics (with emphasis on mercury)

- Improving ability to assess exposure from utility air toxics emissions at relevant receptor locations.
- Developing improved methods to estimate the atmospheric concentration and deposition of air toxics at user-specified receptors and relate those estimates to emissions from a single source or group of sources.
- Assessing boundary conditions for regional source-receptor modeling and the importance on a global scale of chemical reactions that bear on the distribution of mercury.

Assessing health effects of nickel exposure.

- Providing an independent review of recent health effects data on exposure to nickel compounds that are relevant to utility emissions.
- Determining the impact of recent findings concerning nickel cancer health effects on future risk assessments.
- Providing background information for a proactive approach to air toxics issues.

Assessing health effects of exposure to arsenic and other air toxics.

- Developing new data to reduce uncertainties related to arsenic in coal fly ash. Other toxic substances—for example, chromium and dioxins (toxicity equivalent factors)—will be addressed as well in light of emerging regulatory issues.

- Establishing scientific data on critical aspects of toxicological modes of action for arsenic (determining potential bioavailability of arsenic from occupational exposure and advancing a biologically-based mode of action arsenic health risk model).

- Reviewing existing health effects information to determine accurate risks related to power plant emissions.

Providing data enhancements to the Mercury Cycling Model System.

- Quantifying the transformations, movement, and fate of mercury in aquatic ecosystems, leading to more accurate assessments of mercury exposure.
- Updating the dynamic model, developed and demonstrated for cold climates, to incorporate more complete food webs, to simulate warm-climate water bodies, to include the most recent physicochemical results on mercury, and to investigate how variations in water quality affect mercury concentrations in fish in various aquatic ecosystem studies.

Updating and refining the Comprehensive Risk Assessment Framework for Toxics (CRAFT) model.

- Refining the CRAFT methodology, a tool for evaluating health risks associated with individual power plants and entire utility systems.
- Updating the Air Emissions Risk Assessment Model (AERAM) methodology to incorporate state-of-the-science methods (e.g., enhancements for site-specific factors such as sensitive subpopulations, ranges of multipathway factors for multimedia screening and improved health dose-response approach).
- Quantifying potential benefits due to reduced risks by considering life-cycle factors.

Evaluating ecosystem effects of mercury exposure by performing an ecological risk assessment of mercury impacts on fish-eating wildlife.

- Performing field studies for selected sites to evaluate ecological risk from mercury emissions that may result from wild animals and birds ingesting methylmercury-contaminated fish.

Determining environmental consequences of ecological and human exposure to multiple toxic agents, including arsenic, mercury, and selenium.

- Addressing questions concerning potential ameliorative, synergistic, or antagonistic interactions among pollutants in natural systems and with respect to human exposure.

- Convening periodic “expert workshops” on this issue and publishing the proceedings in peer-reviewed form.
- Evaluating ecosystem effects of mercury exposure by performing an ecological risk assessment of mercury impacts on fish-eating wildlife.
- Performing field studies for selected sites to evaluate ecological risk from mercury emissions that may result from wild animals and birds ingesting methylmercury-contaminated fish.
- Initiating experimental studies at later stages of the project to examine realistic exposures, following improvements in sampling procedures.

Project Title: TARGET 97 GROUNDWATER AND COMBUSTION BY-PRODUCTS MANAGEMENT

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Diversified Program; Mururka Ishwar; Stephen D. Mueller; American Electric Power Service Co; Battelle Pacific Northwest Laboratories; META Environmental Inc; Natural Resource Technology Inc; Ohio Edison Company; Science & Technology Management Inc; Southern Company Services Inc; Tennessee Valley Authority; Tetra Tech Inc; University of North Dakota; Wisconsin Electric Power Company.

Contract Amount: 1999: \$390,000
2000: \$390,000

Total Contract: \$780,000

Match Funding: 1999: \$2,387,775
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Ken Ladwig,
(414) 785-5952

Commission Project Manager: Tom Tanton,
(916) 654-4515

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to deliver R&D results on leaching, attenuation, and fate of metals from combustion by-products disposal facilities to strengthen the basis for cost-effective regulations. Leaks and releases of fuel oils at power plants have resulted in contamination of subsurface soils and groundwater, requiring innovative approaches for remediation. Similarly, the storage of coal on land has resulted in the generation of leachates containing metals and acidity which are subject to surface and subsurface migration. This EPRI target also produces

innovative methods for managing wastes and restoring soils and groundwater contaminated by sources other than power plant by-products. Databases and fate and transport software will be developed or enhanced to enable members to cost-effectively manage contaminated sites while protecting the surrounding environment.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California’s electricity by determining cost-effective methods for remediating contaminated land and groundwater; and
- Improving the environmental and public health costs/risks of California’s electricity by effectively cleaning up the environment, thereby reducing human and ecological exposure to chemical contaminants.

Proposed Outcomes:

Protect California soil and groundwater by providing scientific and engineering knowledge (software, information, manuals, and improved insights) into the management of chemicals in disposal sites, landfills, impoundments, and power plant storage facilities.

- Compiling the Combustion By-Products Environmental Analysis System to answer regulatory and risk questions about the release, attenuation, and fate/transport of metals.
- Synthesizing the Environmental Performance Reference Manuals for Landfills and Ponds.
- Providing laboratory, pilot and field-scale testing to demonstrate effectiveness and limitations of alternative management methods for coal mill rejects at power plants and establish methods to control acid leachates from coal piles.

Improve soil and groundwater quality by providing characterization and remediation methods, information, and tools.

- Developing methods to characterize groundwater quality and to effectively remediate groundwater contamination.
- Providing Toxic Release Inventory (TRI) technical information.
- Delivering software (LARK-TRIPP) and chemical composition information (from sampling and analysis) to assist in calculating land release amounts for TRI reporting.
- Providing risk analysis of land releases of inorganic metals.
- Developing reliable rates and coefficient data for leaching and attenuation of a number of metals (boron, manganese, arsenic, nickel, and vanadium).
- Providing technical analysis of U.S. EPA’s drinking water standards.

- Delivering an updated version of MANAGES that includes technical and user enhancements. MANAGES is a database management system for the storage, analysis, and reporting of water quality data. It includes statistical tests from U.S. EPA's GRITS/STAT package to create reports. Groundwater, surface water, and geological data obtained in site investigations and monitoring programs can all be stored, analyzed, retrieved, and displayed in graphs and tables in MANAGES.
- Evaluating methods for remediating spills of petroleum and fuel products, such as MTBE. Technologies include bio-venting, natural attenuation, air sparging, and vacuum extraction.

Project Title: TARGET 103 FISH PROTECTION ISSUES (CLEAN WATER ACT, SECTIONS 316 A&B)

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Alden Research Laboratory Inc; Applied Biomathematics Inc; Duke Energy Corporation; EA Engineering, Science & Technology; Langhei Ecology LLC; Lockheed Martin Energy Systems Inc; Tennessee Valley Authority; Tetra Tech Inc; EPRI Conference Blan; Kenneth Rose.

Contract Amount: 1999: \$328,375
2000: \$328,375

Total Contract: \$656,750

Match Funding: 1999: \$2,838,013

Total Match: \$3,166,288
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Doug Dixon,
(804)642-1025

Commission Project Manager: Marc Sazaki,
(916) 654-5061

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to provide methods for studying fish entrainment and impingement mortality and generate results for fish population predictions that will be used to address biological community and biodiversity risks associated with power plant and industrial facilities operations. The protection of single fish species and aquatic communities is a primary focus of water permitting for coal, oil, gas, and nuclear power plants and industrial facilities under Clean Water Act Section 316(a) (heated and chlorinated cooling water discharges), and Section 316(b) (entrainment into intakes and impingement

on intake screens). This EPRI target will support cost-effective fish protection and facility operational decision making.

This project supports the PIER Program objectives of:

- Improving the environment costs/risks of California's electricity by studying how to reduce the negative effects of thermal power plants (using once-through cooling) on aquatic resources in freshwater and marine environments; and
- Improving the public health costs/risks of California's electricity by protecting fish in cost effective ways to minimize environmental impacts on aquatic environments which impact humans.

Proposed Outcomes:

Provide California with effective "best technology available" (BTA) engineering methods for cooling system intakes.

- Evaluate BTA engineering methods for cooling system intakes.
- Develop the intake structure database.
- Develop the 316(b) Fish Protection Synthesis report (Intake Fish Protection System. Assessments and Intake Structure/Fish Protection Technical Evaluations to Support Compliance).

Provide objective science and engineering to the California energy enterprise debate in water use impacts.

- Organizing workshops and conferences on power-plant-induced water use impacts on aquatic resources.

Develop accurate ecological risk assessment tools to assess the effects of power plant operation on individual fish and the risks to aquatic communities for cost-effective fish protection options.

- Develop Aquatic Ecosystem Evaluation Methods, Ecological Risk Assessment Frameworks, Compensation Mechanisms in Fish Populations (CompMech), and Thermal Discharge Risk Analyses.

Project Title: TARGET 105 FACILITIES WATER MANAGEMENT

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Di Filippo Michael; Lytle Mel C; Alabama Power Company; BetzDearborn, Inc.; Gannett Fleming, Inc.; Puckorius & Associates Inc; University of California, Berkeley; University of Iowa; University of Southern California; Water Systems Specialists Inc.

Contract Amount: 1999: \$ 69,000
2000: \$69,000
Total Contract: \$138,000
Match Funding: 1999: \$856,815
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Kent Zammit,
(650) 855-2097

Commission Project Manager: Joe O'Hagan,
(916) 653-1651

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to develop and implement cost-effective strategies for controlling biofouling, treating wastewater, and treating and recycling cooling water while maintaining minimal impact on the environment. This EPRI target will focus on strategies that include reducing biocide discharges, removing heavy metals, minimizing nitrogen compounds to reduce eutrophication (an aquatic environment wherein plant life is favored over animal life) of water resources, and reducing bioaccumulative pollutants from plant wastewater. For example, EPRI has demonstrated the use of constructed wetlands for treatment of point- and non-point source aqueous discharges.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by developing cost-effective alternative water sources and alternative technologies/methods of treatment of these alternative water sources. The purposes of these alternatives are to minimize environmental impact at reduced costs for treatment of cooling water and increased water recycling/reuse, while improving plant performance and preventing corrosion damage; and
- Improving the environmental and public health costs/risks of California's electricity by providing solutions that reduce or eliminate the water-related impacts of electricity generation in California.

Proposed Outcomes:

Providing biofouling control and plant performance strategies.

- Develop guidelines for use of conventional biocides to meet NPDES permit limits.
- Develop alternative nontoxic biocides for the control of macro- and microbiofouling to satisfy facility performance standards while alleviating compliance concerns.
- Conduct field studies/demonstrations and commercialize promising new technologies.

Providing cost-effective wastewater treatment strategies.

- Develop guidelines for removal of nitrogen compounds.
- Develop alternative wastewater treatment technologies to comply with stringent permit levels: iron-coated sand (which reduces solid waste volumes relative to iron coprecipitation), troika acid systems, and constructed wetlands (which can be used to treat diluted, variable flow discharges).

Providing cooling water treatment and reuse strategies.

- Develop guidelines for plant water recycling and reuse.
- Provide cost-effective cooling water treatment tools while improving plant performance and reducing corrosion damage.
- Provide studies to reduce the costs of dry cooling technologies and to promote dry cooling alternative (via tailored collaboration projects).

Project Title: TARGET 107 PLANT MULTIMEDIA TOXICS CHARACTERIZATION (PISCES)

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Carnegie Mellon University; CH2M Hill, Inc.; Fossil Energy Research Corp.; METCO Environmental Inc; Mostardi-Platt Associates Inc; Quality Associates Int'l Canada Ltd.; Radian International LLC; RMB Consulting and Research Inc; Tennessee Valley Authority; TRW Inc; U S Geological Survey; University of Louisville; University of North Dakota; Bevilacqua Knight

Contract Amount: 1999: \$345,000
2000: \$345,000
Total Contract: \$690,000
Match Funding: 1999: \$3,849,810
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Babu Nott, (650) 855-7946

Commission Project Manager: Joe O'Hagan,
(916) 653-1651

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to measure and characterize potentially toxic substances in air, water, and solid waste streams emanating from electric power plants. This effort is critical for managing toxic emissions and discharges in an environmentally acceptable and cost-effective manner. EPRI's PISCES (Power Plant Integrated Systems: Chemical Emissions Studies) project was launched

in 1988 to collect and analyze power plant trace substances data for multimedia discharge/emissions implications. PISCES data also enable meaningful analysis of the health risks posed by power generation emissions and discharges. To date, the data generated by the PISCES project have been provided to the U.S. EPA (in EPRI's Synthesis Report) and used EPA's report to Congress on hazardous air pollutants. The tools provided in this target can be utilized to assess opportunities for pollution prevention, to evaluate the impact of alternative strategies, and to establish benchmarks for pollutant inventory and tracking. In addition, work will be initiated to address material balance studies involving such key elements as carbon, sulfur, and nitrogen that are associated with such issues as global climate change, acid deposition, and coastal water nitrification.

This project supports the PIER Program objectives of:

- Improving the environmental and public health costs/risks of California's electricity by providing:
 - Meaningful analysis of the health risks posed by power plant emissions and discharges;
 - Assessment of opportunities for pollution prevention and of impact of alternative strategies;
 - Establishment of benchmarks for pollutant inventory and tracking; and
 - Research results on global climate change, acid deposition, and coastal water nitrification.

Proposed Outcomes:

Improve the PISCES modeling capabilities by conducting characterization field tests to accurately measure multimedia emissions, upgrading the database, and expanding the chemical assessment model.

- Conduct field tests to measure air toxics emissions from facilities using alternative fuels such as biomass and Orimulsion, and from advanced generation facilities such as combustion turbines and fluidized bed systems.
- Conduct the Hazardous Air Pollutants (HAPs) Conference to provide an opportunity for information exchange between EPRI, funders, U.S. EPA, and state regulators.

- Update the PISCES Database, a comprehensive multimedia database, to provide for a more comprehensive set of data on solid, liquid, and gas process streams at power plants.
- Conduct field tests to characterize trace substances in water and waste streams at power plants.
- Issue technical reports containing a description of the field testing approach, the sampling and analytical protocols used, the measurements of trace substances in various plant streams, toxics control systems performance, material balance studies, toxics sources, and preliminary water and waste management options.
- Organize the Clean Water Conference to facilitate information exchange among members, U.S. EPA, and state regulators.
- Expand the PISCES plant chemical assessment model to more fully address water streams (specifically to include wastewater treatment/management modules) and to include economic modules.
- Conduct training workshops to facilitate application of the PISCES Model by target funders.

Providing accurate characterization data on solids (including fuels, reagents, by-products, and solid wastes) to support cost-effective, environmentally acceptable power plant operation and management.

- Develop accurate flue gas toxics measurement methods to accurately determine the associated health risks.

Determining more accurate and sensitive methods for analyzing organics such as dioxins to avoid "non-detects", especially if the thresholds for the release of these chemicals are significantly lowered (for example, for TRI reporting).

- Assess methods for speciation of arsenic and chromium to accurately measure the species of the metals in utility flue gas emissions to aid in determining their realistic health risk.

PROJECTS FUNDED IN 1999 THROUGH COLLABORATIVE RESEARCH WITH THE GAS RESEARCH INSTITUTE

Project Title: ADVANCED FUEL CELLS (#165)

Contract #: 100-98-003 (#1)

Contractor and Major Subcontractors: Gas Research Institute (GRI)

Contract Amount: 1999: \$25,000
2000: \$43,000

Contractor Project Manager: Ron Edelstein,
(773) 399-8116

Commission Project Manager: Mike Batham,
(916) 654-4548

Project Description: The purpose of this project is to develop cost-effective, highly efficient fuel cell technology for distributed power generation from natural gas that has broad market implications for residential, commercial, industrial, and power generation customers. This project is designed to capitalize on the results of previous GRI research that identified innovative cell designs and materials to reduce the operating temperatures of solid oxide-fuel cells from 1000 degrees C to 700 degrees C. Those advances will enable large savings in the cost of the cells as well as the prospect of lower maintenance and longer life.

This project supports the PIER Program objectives of:

- Improving the environmental and public health costs/risk of California's electricity because fuel cells emit low levels of atmospheric emissions and reduce the level of noise pollution vis-a-vis large scale power plants; and
- Improving the energy cost and value of California electricity by providing high, fuel-to-electricity conversion efficiency.

Proposed Outcomes:

- Provide the design of a low-cost, high-efficiency advanced cell stack.
- Provide fuel cell manufacturers with laboratory demonstrations of how to design and assemble solid oxide fuel cell stacks that operate below 700 degrees C with very high efficiencies and power densities.
- By 2001, the project will result in fuel cell stacks that can be developed for under \$300 per kilowatt with electrical efficiencies greater than 50 percent.
- By 2003, provide an evaluation of fuel processing options.

Project Status: Project is on schedule, within budget and is expected to achieve proposed outcomes.

Project Title: DISTRIBUTED GENERATION (#733)

Contract #: 100-98-003 (#2)

Contractor and Major Subcontractors: Gas Research Institute (GRI)

Contract Amount: 1999: \$12,500
2000: \$28,500

Contractor Project Manager: Ron Edelstein,
(773) 399-8116

Commission Project Manager: Jairam Gopal,
(916) 654-4880

Project Description: The purpose of this project is to identify the application characteristics and technical requirements for the strategic utilization of gas-fired distributed generation beyond the electric distribution substation. The tasks undertaken in this program include 1) preparing an economic assessment of the market potential for installing distributed generation units, 2) developing modeling tools to identify options available to customers, and 3) developing integrated interconnection systems.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by utilizing natural gas-fired distributed generation technologies; and
- Improving the public health costs/risks of California's electricity by advancing the use of low-emission natural gas.

Proposed Outcomes:

During 2000, the following tasks will be completed:

- Provide benefits, impacts, and issues information from four field test applications;
- Provide two advanced controls and communications systems for distributed generation; and
- Provide reports on infrastructure and interconnection system requirements, as well as communication protocol needs.

Project Status: Project is on schedule, within budget and is expected to achieve proposed outcomes.

Project Title: INDUSTRIAL WASTE PROCESSING (#825)

Contract #: 100-98-003 (#3)

Contractor and Major Subcontractors: Gas Research Institute (GRI)

Contract Amount: 1999: \$75,000
2000: \$29,000

Contractor Project Manager: Ron Edelstein, (773) 399-8116

Commission Contract Manager: John Sugar, (916) 654-4563

Project Description: The purpose of this project is to develop energy-efficient processes that reduce the cost and energy consumption associated with the treatment and disposal of industrial, commercial, and residential waste streams. Major activities under this project are placed in two categories. The first focuses on a cement-lock technology process that will convert contaminated sludge into environmentally safe cement. This technology could reduce the disposal cost of contaminated materials by \$25 per ton. The second, an advanced process to convert organic waste into graphite and oil for industrial and commercial use, is in the early stages of development. If successful, a pilot test facility will develop data for full-scale waste reduction in food processing, petroleum, tires, plastics, municipal solid waste, sewage sludge, and animal husbandry.

This project supports the PIER Program objectives of:

- Improving the environmental and public health costs/risks of California's electricity by providing a process to convert contaminated sludge into environmentally safe cement.
- Improving the energy cost/value of California's electricity by reducing the energy used for disposal of contaminated sludge and organic waste by California energy consumers.

Proposed Outcomes:

- Design and construct a two-ton per day pilot plant for converting sewage sludge in the Seattle area. The commercial developer is Micro-Gas Energy International.
- Provide laboratory results of the sludge conversion technology for a variety of waste products from the food, paper/pulp, and tire industry.
- Produce a validated cement-locking process technology for a variety of contaminants and a first commercial site to prove the technology.

- By 2001, the thermo-depolymerization portion of the project will provide 1) complete laboratory validation of sludge conversion technology use in multiple waste stream applications, 2) economic assessment and benefit evaluations of sludge conversion technology, 3) complete process design and optimization for pilot-scale test facility, and 4) a pilot test facility to develop technical data for full-scale industry applications.

Project Status: Project is on schedule, within budget and is expected to achieve proposed outcomes.

Project Title: HIGH EFFICIENCY STEAM GENERATION (#1218)

Contract #: 100-98-003 (#4)

Contractor and Major Subcontractors: Gas Research Institute (GRI)

Contract Amount: 1999: \$37,500
2000: \$37,500

Contractor Project Manager: Ron Edelstein, (773) 399-8116

Commission Contract Manager: Ben Mehta, (916) 654-4044

Project Description: The purpose of this project is to develop high-efficiency, ultra-low NOx emission technologies for industrial packaged boilers. The major activity under the project is the complete field trials of low and ultra-low NOx boiler burners.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by utilizing natural gas-fired low and ultra-low NOx emission technologies; and
- Improving the public health costs/risks of California's electricity by advancing the efficient use of low-emission natural gas.

Proposed Outcomes:

- Complete a field installation in a Department of General Services building in the Sacramento area.
- Deliver a complete engineering design of prototype burners below 9 ppm NOx. The ultimate goal of the project is to develop industrial boilers with efficiencies above 90 percent and NOx emissions below 5 ppm.

Project Status: Project is on schedule, within budget and is expected to achieve proposed outcomes.

Project Title: COMMERCIAL COOLING AND HEATING PUMP APPLICATIONS (#1417)

Contract #: 100-98-003 (#5)

Contractor and Major Subcontractors: Gas Research Institute (GRI)

Contract Amount: 1999: \$45,600
2000: \$31,500

Contractor Project Manager: Ron Edelstein,
(773) 399-8116

Commission Contract Manager: Nancy Jenkins,
(916) 654-4739

Project Description: The purpose of this project is to develop and deploy cost-effective cooling products and maximize their market adoption and use. Major activities under this project include:

- a) Improved chiller performance;
- b) Updated state-of-the-art technologies for existing absorption chillers;
- c) Low-cost, engine-driven heat pump technologies for commercial applications;
- d) Hybrid chiller design protocols; and
- e) Research results of advanced turbine component tests.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing cooling technologies that will reduce electricity consumption by California energy consumers.

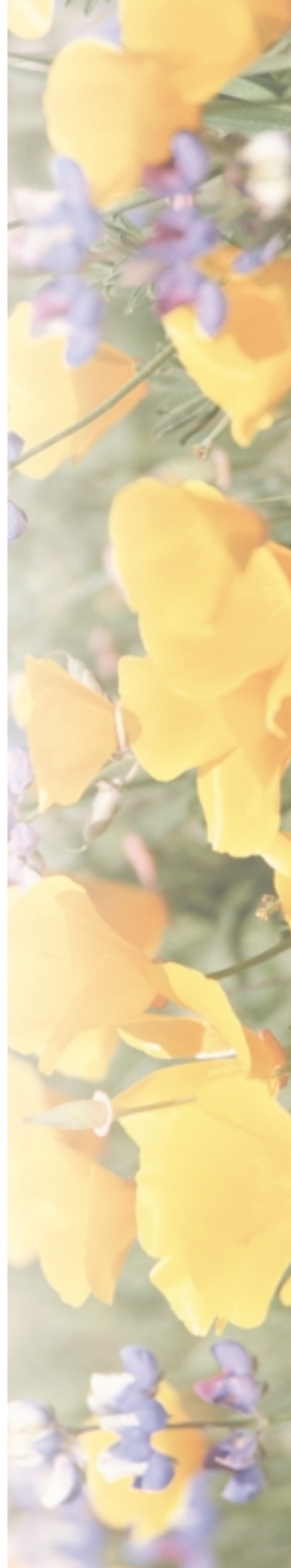
Proposed Outcomes:

- Attain improved chiller performance through fluid formations and corrosion prevention experiments. Deliverables will be in the form of research results that will allow the chillers to operate under conditions that lead to higher efficiencies and lower operating costs.
- Deliver state-of-the-art technology for existing absorption chiller products, specifically: 1) a lower cost single effect absorption chiller with a capacity less than 400 refrigeration tons and 2) a 30-100 ton double effect, direct-fired absorption chiller.
- The project will deliver: 1) a 15-30 refrigeration ton engine-driven heat pump, 2) technical development support for a 3-10 refrigeration ton absorption heat pump, 3) three hybrid chiller designs, and 4) advanced engine chiller product development and testing for commercial cooling applications.

Project Status: Project is on schedule, within budget and is expected to achieve proposed outcomes.

1998-awarded **PIER**projects

- **Projects Funded through the PIER
Program Areas**
- **Projects Funded through
Collaborative Research with the
Electric Power Research Institute**



PROJECTS FUNDED IN 1998 THROUGH THE PIER PROGRAM AREAS

Residential and Commercial Buildings End-Use Energy Efficiency Program Area

Project Title: EVALUATE SMALL COMMERCIAL AIR CONDITIONING UNITS FOR NORTHERN/CENTRAL CALIFORNIA

Contract #: 500-97-010-01

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$500,000

Contractor Project Manager: Lance Elberling,
(925) 866-5519

Commission Contract Manager: R. Michael Martin,
(916) 654-4039

Project Description: This purpose of this project was to:

- Identify those technologies that can potentially improve the energy efficiency of air conditioning applications using rooftop packaged air conditioners on small commercial buildings in hot-dry climates;
- Document the actual performance of two selected technologies through laboratory testing over a range of operating conditions; and
- Provide this information to the HVAC market to encourage the adoption of appropriate technologies.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by providing electricity customers in the commercial sector with information on energy-efficient options to cool their facilities.

Proposed Outcomes: Identify several technologies that could potentially improve the energy efficiency of air conditioning technologies with sufficient detail to enable specifiers of equipment to make well informed choices.

Actual Outcomes:

- Documented several such technologies, with detailed information about performance of two such technologies at a variety of outdoor temperature and humidity conditions.
- Used evaporative condenser precoolers that resulted in greater energy savings in hot dry climates at greater initial cost and is recommended for retrofit applications.

- Used conventional design high efficiency air conditioners with dual compressors which had more modest performance improvements at a lower additional first cost and is recommended for new applications.

Project Title: IMPROVE THE COST EFFECTIVENESS OF BUILDING COMMISSIONING USING NEW TECHNIQUES FOR MEASUREMENT, VERIFICATION AND ANALYSIS

Contract #: 500-97-010-02

Contractor and Major Subcontractors: Pacific Gas and Electric (PG&E) and Schiller Associates; ESS Engineering Inc.; and the Joint Center for Energy Management

Contract Amount: \$300,000

Contractor Project Manager: Steve Blanc, (925) 866-5570

Commission Contract Manager: Joseph Wang,
(916) 654-4026

Project Description: The purpose of this project was to investigate and demonstrate cost-effective and energy-efficient methods for the commissioning of medium to large buildings that have complex mechanical, lighting, and energy management control systems. Commissioning would insure that buildings designed for maximum energy-efficiency perform as intended, thereby reducing energy costs associated with building operations.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by developing tools to analyze, and guarantee, the performance of energy-efficiency measures.

Proposed Outcomes: A major obstacle to widespread adoption of building commissioning is cost. This project created commissioning techniques more effective and less costly to implement. These techniques were tested in a laboratory and at a demonstration site to evaluate their performance. The system included high-quality sensors, a knowledge base to identify system failure, automated communications and data management and data visualization to diagnose building energy performance problems. In addition, the project developed:

- Specifications for a building fault detection and a diagnostics technique that would provide a platform for further commercial development and provide information needed to automate the diagnosis of building energy performance problems;
- A commissioning tool which would focus on the identification of minimum historical data requirements necessary to accurately predict cooling system performance in a typical commercial building; and
- A measurement and verification tool that would allow users to evaluate different measurement scenarios to determine cost effectiveness for specific energy-efficiency measures.

Actual Outcomes:

- Developed a model-independent fault detection and diagnostics tool for variable air volume terminal units. This commissioning tool is based on the use of a residual approach to develop fault detection and diagnostics preprocessors. This avoids the traditional use of model based approach requiring that a tool be calibrated using large amount of historical data.
- Developed a first principles model for integrated cooling systems. This tool focuses on the identification of the minimum historical data requirements necessary to accurately predict cooling system performance in a typical commercial building.
- Developed a building automation control network (BACnet)-based control system driver to facilitate fault detection and diagnostic (FDD) in open architecture energy management control systems. This tool is a generic communications interface for controls systems employing BACnet gateway open protocols. This gives building operators access to building data with any building control systems.
- Developed a measurement and verification value tool that allows the user to evaluate different measurement and verification scenarios to determine cost and saving uncertainty for specific energy efficiency measures.

Project Title: IMPROVE THE COST EFFECTIVENESS OF BUILDING CONTROL SYSTEMS SENSING AND DATA COLLECTION

Contract #: 500-97-010-03

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$250,000

Contractor Project Manager: Steve Blanc, (925) 866-5570

Commission Contract Manager: Joseph Wang, (916) 654-4026

Project Description: The purpose of this project was to investigate methods to reduce the costs of current energy-management systems, such as low-cost building control systems and sensors. Energy management systems allow utility customers to monitor and control their energy consumption and improve the energy-efficiency of the whole building.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by providing utility customers with tools that could help reduce their energy consumption.

Proposed Outcomes:

- Develop a method for determining the accuracy and storage frequency needed for various data acquisition functions in commercial HVAC systems, and
- Specify the use of economics (costs versus benefits) and operating needs to determine accuracy and storage frequency for data collected from commercial HVAC systems.

Actual Outcomes:

- PG&E developed a method for determining the accuracy and storage frequency required for various data acquisition functions in commercial HVAC systems.
- PG&E demonstrated the method on an example building under two different weather profiles (focusing on the air-handling equipment and chilled water temperature) and showed the potential benefits when more accurate equipment and better diagnostic techniques are used.
- PG&E repeated the analysis on several other building types and sizes using a different energy simulation model. The result is a range of recommended measurements, storage frequencies, and potential energy savings for buildings with different annual energy uses.

Project Title: RESIDENTIAL THERMAL DISTRIBUTION SYSTEMS

Contract #: 500-97-013-02

Contractor and Major Subcontractors: California Institute for Energy Efficiency; Lawrence Berkeley National Laboratory; ConSol Consulting

Contract Amount: \$400,000

Contractor Project Manager: Karl Brown, (510) 642-7545

Commission Contract Manager: Dale Trenchel,
(916) 654-4098

Project Description: The purpose of this project was to develop new knowledge and prototype technologies that would improve the energy-efficiency and performance of heating, ventilation and air conditioning (HVAC) equipment in residential buildings. The work included developing and testing the effectiveness and durability of duct sealant technologies for use in residential buildings. New methods of measuring duct leakage were evaluated, and interactions between equipment sizing and the effectiveness of the distribution system to deliver cooling throughout a home were analyzed. A significant issue investigated was the ability of downsized equipment and good distribution systems to deliver the same cooling benefits as larger, typical HVAC systems, but at a lower cost to the consumer.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by providing information, tools and products to reduce HVAC energy consumption in residential buildings. Specifically, this project will develop new procedures to evaluate the longevity of sealants used on residential HVAC ducts and new test methods for measuring energy losses through duct leakage. These results facilitate the reduction of electricity for home heating and cooling use in residential HVAC systems through better duct sealing measures, reduced equipment sizing and improved diagnostics.

Proposed Outcomes:

- Improve duct leakage test methods.
- Update the American Society for Testing and Materials (ASTM) Standard E1554 – Determining External Air Leakage of Air Distribution Systems by Fan Pressurization.
- Develop and introduce a draft ASTM standard for longevity testing of duct sealants.
- Measure the performance of residential cooling equipment and associated distribution systems.
- Compare the REGCAP simulation model to the measured field data.
- Provide technical support to the Commission for updating the Low-Rise Residential Alternative Calculation Method Approval Manual for 1998 Energy Efficiency Standards for Low-Rise Residential Buildings (CEC 1999) and Procedures for HVAC System Design and Installation (for HERS).
- Support ASHRAE, ASTM and U.S. EPA duct leakage research and interface with projects funded by other agencies.

Actual Outcomes:

- This investigation yielded a new duct leakage test called DeltaQ.
- The existing ASTM Standard (E1554) for measuring duct leakage has been rewritten and submitted to the ASTM standards review process.
- A draft ASTM standard for longevity testing of duct sealants was developed. A draft was submitted to ASTM subcommittee E06.41 for balloting and comment. The comments on the draft resulted in changes to the test method and apparatus. A new test apparatus was constructed with funding from the U.S. DOE.
- Simulations of summer temperature pulldown time have shown that duct system improvements can be combined with equipment downsizing to reduce initial cost, energy consumption, and peak power and still provide equivalent or superior comfort.
- Air conditioner name plate capacity ratings alone are a poor indicator of how much cooling will actually be delivered to the conditioned space. Duct system efficiency can have as large an impact on performance as variations in Seasonal Energy Efficiency Ratio (SEER). Installing high SEER units can reduce energy consumption with no apparent drawbacks.
- Duct efficiency calculations are included in the Low-Rise Residential Alternative Calculation Method Approval Manual for 1998 Energy Efficiency Standards for Low-Rise Residential Buildings (CEC 1999).
- Procedures for HVAC System Design and Installation (for Home Energy Raters) have been updated.
- Field-testing has shown that standard flowhoods can be poor for measuring residential register flows.

Project Title: COMMERCIAL THERMAL DISTRIBUTION SYSTEMS

Contract #: 500-97-013-04

Contractor and Major Subcontractors: California Institute of Energy Efficiency (CIEE) and Lawrence Berkeley National Laboratory (LBNL)

Contract Amount: \$400,000

Contractor Project Manager: Karl Brown, (510) 643-1617

Commission Contract Manager: Mazi Shirakh,
(916) 654-3839

Project Description: The purpose of this project was to develop information and products that would improve the

energy-efficiency and performance of heating, ventilation and air conditioning (HVAC) equipment in commercial buildings. This project assessed the performance of air-duct systems in California's commercial buildings, developed and tested duct-sealant and duct-encapsulation technologies specifically for applications in commercial buildings, and developed tools to diagnose the energy-performance of commercial building fan systems.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing peak demand and improving load factor, leading to reduced infrastructure costs and system reliability risks;
- Improving the energy cost/value of California's electricity by improving thermal performance of the commercial thermal distribution systems. Current data suggests that leakage in commercial thermal distribution systems is in excess of 20 percent, with additional excess energy use caused by fan system problems; and
- Improving the environmental and public health costs/risks of California's electricity by improving indoor air quality through improved control of air flows and duct encapsulation technology.

Proposed Outcomes:

- Advance knowledge about performance and losses for commercial building thermal distribution systems.
- Evaluate the potential for reducing thermal losses through duct sealing, duct insulation, and improved equipment sizing.
- Advances in innovative techniques for sealing ducts and encapsulating internal duct insulation.
- Advances in protocols and techniques for testing, analyzing and diagnosing energy-related problems in large commercial building fan systems.

Actual Outcomes:

- Identified significant duct leakage in large commercial buildings, with large associated energy losses.
- Confirmed significant potential energy savings from duct sealing in large commercial buildings and identified building model enhancements that will allow incorporation of duct performance improvements in building energy standards.
- Improved prototype equipment and field experience for duct sealing and encapsulation technology.
- Made advances in tracer gas measurement techniques and refined protocols for diagnosing energy losses in large building fan systems.

Project Title: DIAGNOSTICS FOR BUILDING COMMISSIONING AND OPERATIONS

Contract #: 500-97-013-05

Contractor and Major Subcontractors: California Institute for Energy Efficiency (CIEE) and University of San Diego; SuperSymmetry; Stanford University and Jones Lang Wootten; California Inc.

Contract Amount: \$350,000

Contractor Project Manager: Carl Blumstein, (510) 642-9590 ext.202

Commission Contract Manager: Joseph Wang, (916) 654-4026

Project Description: The purpose of this project was to demonstrate a system that allows building occupants to monitor the energy use within their building, so they may determine if the building is performing at its optimum energy-efficiency level. This system will permit building occupants to improve the energy-efficiency of their buildings by facilitating the identification of energy performance problems.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by helping customers optimize their building systems to perform at their peak energy efficiency.

Proposed Outcomes: This project was to demonstrate an advanced operator information, monitoring and diagnostics system (IMDS) for whole-building commissioning and operations. The system and project objectives included:

- High-quality sensors.
- Knowledge base to identify system failure.
- Automated communications and data management.
- Data visualization to diagnose building energy performance problems.
- Evaluating the energy savings and other non-energy benefits of IMDS use. The objective is to reduce total energy use and energy cost by 15 percent without sacrificing any other building services or performance issues.
- Developing and demonstrating techniques to automate fault detection and diagnosis using a steady-state chiller model and evolutionary programming for self-learning systems.
- Evaluating the decision making and technology adoption processes in the commercial buildings sector.

Actual Outcomes:

- LBNL successfully demonstrated that the IMDS is very useful in evaluating the building's performance. The building operators perceive significant improvements in the performance of the building. These include improvements in control, reduced comfort complaints, and the identification of significant energy savings. Even more significant is that the IMDS has been useful in identifying an ongoing set of problems at the building that are related to problems inherent in the control systems.
- LBNL developed a prototype stand-alone chiller data analysis tool was developed to provide the operations staff with additional diagnostic capabilities beyond the IMDS. However, neither the chiller diagnostic tools nor the utilization techniques are mature at this point.

The project did not achieve the goal of 15 percent overall energy savings. However, the system is likely to payback over the next few years if the controls retrofit is complete, the fan VFD savings are seen, and the steam savings are realized. The IMDS has not shown a payback based on energy savings. It has demonstrated that the technology is of significant value and the staff wants to continue to use such technology in other buildings.

Project Title: BUILDING DESIGN ADVISOR

Contract #: 500-97-013-08

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$350,000

Contractor Project Manager: Konstantinos Papamichael, (510) 486-6854

CIEE Project Manager: Carl Blumstein, (510) 642-9590, extension 202

Commission Contract Manager: Tav Commins, (916) 653-1598

Project Description: This project updated the Building Design Advisor (BDA), a Windows-based computer program that facilitates decision making through integrated use of multiple analysis tools and databases. This tool, when completed, will enable building designers to consider various energy efficiency options during the design stage of new buildings, when energy efficiency measures are typically more cost effective. The main deliverable for this project was to integrate DOE-2 into the tool. DOE-2 is a building energy simulation program that is the industry standard for producing detailed and accurate energy performance simulations.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by allowing energy-saving measures to be integrated into the early design of a building, thereby making energy-efficient measures more cost effective.

Proposed Outcomes:

- Bring the initial BDA software from an unstable, incomplete Beta release to a robust 1.0 version for distribution to academia and the building industry for evaluation and feedback.
- Develop an updated 2.0 version with links to DOE-2. This will demonstrate the expandability of the BDA software to include links to simulation tools already accepted and trusted by the building industry and make the BDA more appealing for use in actual projects.
- Elicit industry feedback to identify industry needs and desires, towards BDA versions that will be appropriate for use in actual projects.
- Prepare a commercialization strategy for widespread distribution of the software with proper user support.
- Initiate developing a BDA-based Issue Based Information System (IBIS) that will facilitate the use of the BDA as a collaborative, concurrent design tool, and greatly enhance developing links to tools that address the whole building life cycle, from design through construction and commissioning, to operation and eventual demolition.

Actual Outcomes:

- The BDA 1.0 has been in distribution since January 1999, free of charge through the Internet. To date, more than 450 reviewers have downloaded the software from the project's Web site. Approximately 150 reviewers are from academia (professors and students) and 300 are from the building industry (architects, engineers, energy consultants, etc.).
- Beta releases of BDA 2.0, with links to DOE-2, were used in workshops with architects and engineers in the San Francisco, Los Angeles, and Sacramento areas. Useful comments were elicited through extensive interactions between the software developers and the building industry participants. Comments and suggestions were organized and prioritized based on workshop participants input.
- The response to the BDA concept has been enthusiastic and has resulted in very useful feedback on the specific needs of building design professionals. Several university professors plan to use the BDA software in relevant architectural and engineering courses.

- A commercialization report was prepared.
- The design of the BDA-based IBIS was completed, with potential use scenarios and graphical user interface elements for implementation in future versions of the BDA software.

Project Title: ALTERNATIVES TO COMPRESSOR COOLING

Contract #: 500-97-013-03

Contractor: California Institute for Energy Efficiency (CIEE)

Contract Amount: \$350,000

Contractor Project Manager: Karl Brown, (510) 486-5338

Commission Contract Manager: Randel Riedel, (916) 654-4109

Project Description: The purpose of this project was to develop and evaluate house designs capable of providing comfort in California transition climates without the use of conventional compressor-based cooling. Compressor-based cooling is growing rapidly in transition climate zones inland from major California coastal urban centers. However, the low hours of air conditioning use in these areas create an extremely poor load factor with a substantial adverse effect on costs of service and electric system operations.

Compressor-less cooling will result in energy and peak demand savings in the warmer climate zones in California. With the highest practical market penetration, the potential avoided increase in new electric demand is estimated to be 0.5 Watt per square foot of new house area averaged across all new residential construction. The equivalent potential in retrofit is estimated to be one Gigawatt in California. Load factors would be improved with a substantial increase in system reliability and decrease in cost of service. In addition, air-conditioning system size will be reduced in more severe climates through the adoption of project design concepts.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing peak electrical demand created by compressor-based air conditioning; and
- Improving the energy cost/value of California's electricity by reducing energy use and costs created by residential space cooling during summer "heat storms."

Proposed Outcomes:

- Evaluate pilot houses and/or subdivisions using project-developed house designs.

- Develop a prototype cost/capability-optimized alternative cooling system controller.
- Provide technology transfer through design information dissemination, assistance, and evaluation.
- Promote the project with design competitions.
- Develop applications information to assist market transformation programs.

Actual Outcomes:

Evaluate pilot houses and/or subdivisions using project-developed house designs.

- A Northern California prototype house design was developed.
- A Southern California prototype house was modified and a variation with street access to the garage was designed. Builders and developers in California were solicited to initiate a pilot house or subdivision program. Everyone contacted was interested in the prototype concepts and designs, but were unwilling or unable to commit to building a pilot project.
- An expanded definition of "comfort" and the impact of Time of Use charges were both found to support the technology concept of the compressorless cooling design.
- The Northern California prototype house performance simulation was not completed, so applications and sizing information is based on the results from the Southern California house. The Northern California house is expected to perform even better.
- Performance simulations demonstrated that compressorless technologies will not maintain comfort in the Southern California prototype house in all California transitional climates. However, a substantially downsized compressor (1.5 tons) operated in concert with the night ventilation and house design will maintain comfort in all transitional climate areas and in all but the most severe hotter inland climates. The performance simulations for this phase of the ACC project have been re-checked and are correct.
- Appraisers indicated that the disadvantages of a smaller compressor or no compressor would be offset by the superior construction of this particular type of residence. However, they would prefer to make their determination of energy tradeoffs based on an existing model for comparison with standard designs and construction.

Develop a prototype cost/capability-optimized alternative cooling system controller.

- A prototype low energy cooling control system to enable operation of the house for night ventilation was developed and tested in two houses. The result was a demonstrated reduction in compressor cooling use while comfort was maintained in a moderately hot climate.
- Based on occupant interviews, the user interface was successfully used by the occupants to maintain comfort and reduce compressor use during an overheated period.
- Occupants were able to operate the controller effectively although they did not necessarily understand the technical details of the mechanical system.
- Feedback from the controller web page simulation confirmed the usefulness of the comfort range strategy in the interface design and identified modifications to the interface that will be revised in the next phase.

Provide technology transfer through design information dissemination, assistance, and evaluation.

- The PIER research team presented the house designs, control design and program concepts to many individual builders, developers, architects and owners.
- The house designs were presented in more formal venues including: Los Angeles Department of Water and Power in regard to Playa Vista Development, the San Diego Regional Energy Office, LBNL Noon Lecture Series, CIEE Tri-annual Review, NAHB Green Building Conference, Green Building Challenge Conference, poster session at the PIER Conference “Energy Innovations ‘99”, and to the following individuals in Washington, D.C.: Rich Karney (DOE), Mark Ginsberg (FEMP Director), George James (Building America), Larry Zarker (PATH), Sam Raskin (ENERGYSTAR Homes, EPA), Mark Nowak (NAHB Research Center).
- The following publications were produced: *Smart Thinking About Smart Houses*, and *Ventilation Cooling Without Losing Control*.

Promote the project with design competitions.

- In 1999, a professional slide show and script on the concepts and prototype designs were developed and presented during the “Gold Nugget Awards” held at the annual Western Building Show.
- Two custom homes with low energy cooling, shading, thermal mass and night ventilation received the “1999 Summer Performance Awards”.

Develop applications information to assist market transformation programs.

Current trends in the residential industry which are complementary with compressorless strategies provide opportunities

for market adoption. These include interest in “green buildings”, “new urbanism”, “concern for indoor air quality, health and environment”, Energy Efficient Mortgages, and the embracing of “quality” as a marketing strategy.

Project Title: HIGH-EFFICIENCY LIGHTING TORCHIERES

Contract #: 500-97-013-06

Contractor and Major Subcontractors: California Institute of Energy Efficiency (CIEE) and Lawrence Berkeley National Laboratory (LBNL)

Contract Amount: \$90,000

Contractor Project Manager: Carl Blumstein, (510) 642-9590 ext.202

Commission Contract Manager: Mazi Shirakh, (916) 654-3839

Project Description: This purpose of this project was to develop portable, high-efficiency, indirect torchiere fixtures that would use one of the next generation high-efficacy electrodeless or electroded fluorescent lamps. These fixtures are targeted at the commercial office interiors where there is a demand for high color quality and low-glare portable lighting. This proposed effort was a first step in the development and demonstration of new office torchiere lighting systems. Wide adoption of the technology developed in this project would significantly increase the penetration of high-efficiency fixtures in commercial interiors.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California’s electricity by improving the efficacy of the very popular torchieres. Incandescent torchieres are very inefficient and present a fire hazard. The proposed advanced torchieres reduce electrical consumption by 75 percent.

Proposed Outcomes:

- Produce prototype fixtures that exploit the properties of the next generation of high efficiency advanced fluorescent lamps and advanced optical reflectors.
- The prototypes were expected to have high color quality and low glare suitable for use in commercial office spaces.

Actual Outcomes:

- The LBNL contract discusses high efficiency lamps with efficacies in the range of 83 to 100 lumens per watt. The actual outcome was lamps with efficacies in the 72 to 79 lumens per watt. The commercially available lamps currently have efficacies in the 55 to 69 lumens per watt.

- The proposed lamps have color temperatures and color rendering indexes that are comparable or superior to what is commercially available.
- LBNL also experimented with different types of optical reflecting materials, determining that white paint is the most practical due to cost considerations.
- The retail costs are expected to be around \$60-\$70 a unit which is competitive with what is available now (which is around \$50-\$60 for high-end products).
- Currently there are no torchieres with the uplight/downlight components and with the range of efficacies discussed above.

Project Title: CIEE COLLABORATIVE PROGRAM PLANNING AND MANAGEMENT

Contract #: 500-97-013-01

Contractor: California Institute of Energy Efficiency (CIEE)

Contract Amount: \$600,000

Contractor Project Manager: Jim Cole, (510) 486-4123

Commission Contract Manager: Gary Klein, (916) 653-8555

Project Description: The purpose of this project was to coordinate the efforts undertaken in the eight CIEE Transition solicitation projects. The project was to provide planning, funding, management and technology transfer activities for these projects. CIEE was the primary link between the Commission's contract managers and the principal investigators. CIEE was to ensure that the administrative and reporting requirements of each project were met.

CIEE was scheduled to release a Request for Proposals (RFP) for the first phase of a new multi-year project known as the Market Transformation Research: New Commercial Buildings Project. This new project was to have been managed by CIEE. CIEE was to maintain an Internet web site that contains information on the Commission-funded Transition Solicitation projects as well as integrate technology transfer activities into the transition project activities.

Proposed Outcomes:

- Manage the research and development of the new end-use efficiency technologies emphasized in CIEE projects.
- Coordinate with the research teams, the CIEE Research Board and other Sponsor representatives in exploring the initial market applications of the new energy efficiency technologies.

- Conduct a review of the CIEE R&D program by an independent peer review panel.

Actual Outcomes:

- Final report for each project produced.
- CIEE recommended the establishment of a statewide, coordinated Emerging Technologies Initiative to the California Board for Energy Efficiency (CBEE) and the California Public Utilities Commission (CPUC) in June and July of 1999.
- CIEE, in collaboration with Energy Commission staff and CIEE Sponsor representatives, prepared and issued a Request for Proposals (RFP) to select a research team and detailed research plan for the CIEE multiyear project: Market Connections for New Commercial Building Technologies.
- CIEE collaborated with Southern California Gas and other CIEE Sponsor representatives in planning and funding two public interest R&D projects involving low NOx, energy efficient combustion of natural gas in industrial, commercial and other market applications.
- Independent peer review conducted in April 1999, concluded that the overall quality of CIEE's R&D program was outstanding.

Project Title: ENERGY EFFICIENT DOWNLIGHTS FOR CALIFORNIA KITCHENS

Contract #: 500-98-020

Contractor: Lawrence Berkeley National Laboratory (LBNL)

Industry Partners: Sacramento Municipal Utility Department (SMUD); Natural Resources Defense Council (NRDC)

Contract Amount:	\$648,603
Match Funding:	\$ 320,028
SMUD	\$150,000
Lithonia Lighting	\$150,000
NRDC	\$20,028

Contractor Project Manager: Stephen Johnson, (510) 486-4274

Commission Contract Manager: Elaine T. Hussey, (916) 654-5006

Project Description: The purpose of this project is to research, develop and demonstrate low-cost, energy-efficient compact fluorescent (CFL) downlights designed specifically for residential kitchen applications. Kitchen lighting is the

largest lighting energy user in Californian homes, accounting for one-quarter of residential lighting operating costs. Therefore, kitchen environments have a large energy savings potential, particularly in new construction.

Successful completion of this project, concluding with a decrease in the price of CFL dimming ballasts that control multiple CFL downlights, will result in overall lower initial costs for CFLs for kitchen lighting, making them more attractive to homeowners. In addition, a 15-25 percent increase in output efficiency will further increase the attractiveness of CFL downlights used to illuminate kitchens, where, typically, brighter than average light is required for food preparation.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by overcoming technical and market issues such as lighting quality, the inability to dim and the high initial costs for CFLs which have provided barriers to the widespread use of CFLs in the residential sector.

Proposed Outcomes:

- Develop single, dimming, electronic ballasts that controls multiple CFL downlights. Developing single, dimming, electronic ballasts that control multiple CFL downlights will reduce the number of ballasts required for a typical kitchen layout of 4-6 fixtures by 75 to 80 percent. This reduction represents an important technical achievement since the highest contributing cost of a CFL downlight system is the ballasts. In CFL downlights with dimming capability, the cost of the ballast can approach 75 percent of the total luminaire cost. This new system will provide high-quality, high-performance, energy-efficient lighting with a significant decrease in initial costs over current CFL downlights.
- Develop thermoplastic fixtures with high efficiency reflective coatings. Current downlight reflector efficiencies range between 50-70 percent, with the industry standard at approximately 65 percent. The relatively low efficiency of these fixtures is a function of their manufacturing process, which leads to a predominance of rotationally symmetrical reflectors. While these symmetric reflectors are somewhat efficient in optically managing small incandescent sources, they do poorly at handling complex CFL lamps. In contrast, injection molding and other plastic molding processes can generate the complicated, optically efficient geometries that will result in output efficiency increases of 15-25 percent over existing CFL reflectors.

Project Status: Project implementation has been delayed due to the loss of one of the original industry partners. Lithonia Lighting is the new industry partner, and contract

preparation is underway. Signing of the contract is subject to delay until there is agreement between U.S. DOE, the National Labs and the Energy Commission on specific terms and conditions applicable to all National Laboratories.

Project Title: INCREASED ENERGY EFFICIENCY OF REFRIGERATORS AND AIR CONDITIONERS THROUGH USE OF ADVANCED POWER ELECTRONICS

Contract #: 500-98-021

Contractor and Major Subcontractors: Energy Savers International and Lawrence Berkeley National Laboratory (LBNL); Ed Vineyard; Hybrid Circuits, Inc.; Sun Frost; Bristol Compressors; Robert Lynette.

Contract Amount: \$411,614

Match Funding: \$114,714

Contractor Project Manager: Jay Jayadev, (650) 964-1596

Commission Contract Manager: R. Michael Martin, (916) 654-4039

Project Description: The goal of this project is to develop an energy-efficient electronic control system by which refrigerators and heat pumps with single-phase compressor motors can be operated more energy efficiently using three-phase motors. Because three-phase motors are more efficient and less costly to manufacture, there is a significant potential for reducing the electrical consumption of refrigerators and other residential appliances. In addition, this project will help decrease the load energy consumption of air conditioners that have a significant effect on peak loads.

Successful completion of this project will increase the efficiency of residential refrigerators by approximately 19 percent, with no increase in cost to consumers. The technology is applicable to other residential appliances that use single-phase motors such as air conditioners, heat pumps, washing machines and clothes dryers, which promises huge energy savings potential for residential appliances.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by making an existing energy technology more efficient, thereby lowering the cost of electricity for refrigeration and cooling to residential customers; and
- Improving the reliability/quality of California's electricity by helping to reduce peak electrical demand from residential cooling.

Proposed Outcomes:

- Develop and demonstrate innovative proprietary power

electronics to convert single-phase power to three-phase power. Converting to three-phase power significantly reduces conversion losses, making the use of three-phase motors economically feasible for residential applications.

- Purchase and modify two compressors, installing one in a conventional design high-efficiency refrigerator and the other in a conventional design heat pump.
- Test the energy efficiency of the modified refrigerator and modified heat pump compared against an unmodified refrigerator and an unmodified heat pump.

Project Status: The contractor has selected the technology to use for this project and has obtained compressors that are currently being modified and tested. This will be followed by mounting the modified compressors in a refrigerator and air conditioner and testing the refrigerator and air conditioner for reliability as well as measuring reductions of energy use.

Project Title: DEVELOPMENT OF AN ADVANCED INDIRECT EVAPORATIVE HEAT EXCHANGER MODULE

Contract #: 500-98-022

Contractor and Major Subcontractors: Davis Energy Group Inc. and Pacific Gas & Electric Co.; Refrigeration Technology Inc.; Cooltech Inc.; and James Ramos & Associates.

Contract Amount: \$248,719

Match Funding: \$84,618

Contractor Project Manager: Richard C. Bourne, (530) 753-1100

Commission Contract Manager: Ray Darby, (916) 654-5074

Project Description: The purpose of this project is to design, develop and test an improved heat exchanger for the advanced indirect evaporative cooling stage of the SmartCool™ two-stage evaporative cooler. This indirect heat exchanger will lower the cost of the SmartCool™ unit by 30 percent, allow for a range of sizes of the unit, and increase efficiency by an estimated 5 percent. A manufacturing strategy will also be developed.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by developing an air conditioning technology that contributes considerably less to peak electrical demand than conventional air conditioning units; and
- Improving the energy cost/value of California's electricity by refining a new energy efficiency technology to make it more market ready.

Proposed Outcomes:

- Lower cost heat exchanger design, allowing the manufacturer to drop the contractor price for a complete SmartCool™ unit from \$1,700 to \$1,200 – the approximate cost of a standard (compressor-based) cooling system of equivalent cooling capacity – making the unit more cost-competitive.
- Thirty percent lower installation costs and 60-80 percent less operating costs than compressor-based cooling.
- Overall efficiency gain of about 5 percent.
- Improved reliability/durability.

Project Status: The project is within budget. The project started late due to the need to identify a new manufacturing partner after the original partner dropped out. The new partner, Des Champs Laboratories, is a well known, major manufacturer of evaporative cooling and heat exchange equipment. The size and capabilities of Des Champs Labs are far greater than the original partner, providing a better match for meeting high-volume manufacturing and other commercialization needs.

Project Title: CONCEPTUAL DESIGN ENERGY ANALYSIS TOOL

Contract #: 500-98-023

Contractor: GeoPraxis; Artifice Inc.

Contract Amount: \$452,655

Match Funding: Artifice Inc. \$65,060

Contractor Project Manager: Tom Conlon, (707) 996-9408

Commission Contract Manager: Tav Commins, (916) 653-1598

Project Description: The purpose of this project is to design and develop an easy-to-use, market transforming energy analysis software module (based on simulation technology) that will be seamlessly integrated with an existing 3-D conceptual building design software tool. The powerful (DOE-2 based) analysis tool will be hidden within the 3-D software tool. Target users will be energy non-experts (primarily architects, design/build contractors, developers) who will be able to generate reliable estimates of the relative energy performance of a new building in its earliest stage of design. The tool's parametric capabilities will allow users to understand and test the energy-related impacts of their designs, including fuel and material choices, system types, orientation, fenestration layout and other key decisions

which often become fixed at this early stage of the construction process.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by helping architects, design/build contractors and developers generate reliable estimates of the energy performance of a building while it is still in its earliest stage of design.

Proposed Outcomes:

- Produce a software product which provides annual energy consumption, peak power demand, and annual energy costs for two modeled alternatives: 1) a code-complying building and 2) a "best practice" building.
- Produce a software product that will facilitate the estimation of building energy consumption during the early stages of architectural design.
- Distribute the programs interface specifications and documentation at no cost.
- Produce readiness plan to commercialize the tool.

Project Status:

The project is on schedule and within budget.

Project Title: ALTERNATIVES TO COMPRESSOR COOLING: PHASE V

Contract #: 500-98-024

Contractor and Major Subcontractors: Davis Energy Group and University of California, Berkeley Solar Group; Loisos/Ubbelohde; Pacific Gas & Electric; ZTECH; CR Communications.

Contract Amount: \$867,683

Match Funding: \$154,437

Contractor Project Manager: David Springer, (916) 753-1100

Commission Contract Manager: Randel R. Riedel, (916) 654-4109

Project Description: The purpose of this project is to improve the energy efficiency of new single-family homes in California transition (mild) and inland climates, while providing indoor comfort and air quality. This project will develop, construct and monitor two new homes, which use "integrated ventilation cooling" instead of central air conditioning. "Integrated ventilation cooling" combines architectural design features, such as glazing orientation and thermal mass, with the contractor's integrated Heating,

Ventilation and Cooling (HVC) unit and HVC advanced control. The integrated HVC unit combines a fan coil unit, containing a variable-speed fan blower and a hot-water coil for ventilation and heating, with a damper system for night-time cooling and ventilation. The HVC unit for inland climates may also include a refrigeration coil for cooling. The HVC advanced control optimizes the integrated HVC unit's operation to maintain indoor comfort levels and ventilation rates.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing peak electrical demand created by compressor-based air conditioning; and
- Improving the energy cost/value of California's electricity by reducing energy use and costs created by residential space cooling during summer "heat storms."

Proposed Outcomes:

The HVC unit will include:

- Integrating dampers for night ventilation cooling.
- Fan coils that will heat the house using the domestic hot water.
- A variable speed blower motor for quiet, efficient heating and ventilation and an optional refrigerant coil for compressor-based cooling.
- Advanced controls, which convey the concept of ventilation cooling to the user, will be improved in this project phase.

Project Status: The Department of General Services signed this contract on September 29, 1999, and the first project team meeting was held on November 4, 1999.

Project Title: A TOOL FOR THE COMPREHENSIVE ANALYSIS OF LOW-RISE RESIDENTIAL BUILDINGS

Contract #: 500-98-025

Contractor and Major Subcontractors: Eley Associates; Catherine Cooper Market Research; J.J. Hirsch and Associates.

Contract Amount: \$216,190

Match Funding: \$200,000

Contractor Project Manager: Charles Eley, (415) 957-1977

Commission Contract Manager: John Eash, (916) 653-7181

Project Description: The purpose of this project is to develop a Windows-based design and analysis software that will assist homeowners and design professionals in evaluating the energy use of residential buildings. The software will

enable homeowners to make informed choices among energy service providers while the building industry will be able to make more informed choices about home designs and product specifications. With a deregulated electricity market, proposals from energy service providers will likely become more complex with time-of-use charges, demand charges, ratchets and perhaps real-time pricing. This tool will enable the unregulated market for electricity to function at a more optimum level because it will enable homeowners to understand their energy use patterns and be better informed in choosing an energy service provider in the unregulated marketplace. In addition, it will enable architects, building designers, contractors and homeowners to evaluate design and/or equipment alternatives and make better decisions about which design strategies to employ or which equipment to specify.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by enabling residential customers to choose energy service providers offering them the best combination of electric rates and energy conservation services by giving them a better understanding of energy use patterns and load profiles.

Proposed Outcomes:

- Leverage existing software technologies to produce a tool that will be useful to a wide sector of the residential building community. The project is building on two significant existing technologies, the DOE-2.2 calculation engine and a set of foundation classes developed by Eley Associates.

Project Status: The project is on schedule and within budget. It is estimated that the Alpha version (for in-house Contractor testing) of the software will be ready by January 1, 2000, and the Beta phase (for homeowner's testing) should be complete by March, 2000 with contract completion by June of 2000.

Project Title: HVAC DISTRIBUTION SYSTEMS IN COMMERCIAL BUILDINGS

Contract #: 500-98-026

Contractor and Major Subcontractors: Lawrence Berkeley National Laboratory (LBNL).

Contract Amount: \$537,000

Contractor Project Manager: Rich Wilson, (510) 486-4678

Commission Contract Manager: Mazi Shirakh,
(916) 654-3839

Project Description: The purpose of this project is to obtain the scientific knowledge to properly measure and compare commercial buildings' thermal-distribution-system performance in terms of energy efficiency and indoor air quality. This new information will be applied to designing better thermal distribution systems in new commercial buildings and retrofitting existing systems to reduce their energy consumption and peak-electrical demand. This project will also develop and test LBNL's aerosol-based duct retrofit technologies to determine the extent to which they reduce duct leakage, conduction losses and energy consumption and demand. Approximately one third of the electricity used in California commercial buildings is consumed by heating, ventilation and air conditioning (HVAC) equipment. Research suggests that the HVAC thermal distribution systems in these buildings suffer from a number of problems, such as duct leakage and thermal losses due to poor duct location.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing peak summer HVAC electrical demand;
- Improving the energy cost/value of California's electricity by eliminating the waste from leaky HVAC distribution systems; and
- Improving the environmental and public health costs/risks of California's electricity by improving indoors air quality through sealing HVAC thermal distribution systems.

Proposed Outcomes:

- Collect data on existing commercial buildings for characterizing the buildings' thermal distribution systems performance.
- Develop metrics to benchmark the performance of the thermal distribution systems.
- Develop and test aerosol-sealing technologies and document the effectiveness of this technology for sealing thermal distribution systems.
- Develop techniques for applying duct coating and sealing material in large commercial buildings that include laboratory and field testing of the equipment.
- Conduct outreach efforts to publicize the results of the research to technical, scientific, trade, and regulatory organizations that can utilize the findings.

Project Status: The contract was signed on August 26, 1999. The project is on schedule.

Project Title: BUILDING SPECIFICATION GUIDELINES FOR ENERGY EFFICIENCY

Contract #: 500-98-027

Contractor and Major Subcontractors: Eley Associates and Taylor Engineering; Cathrine Cooper; SMWM; SDV/ACCI; After Image; John Raeber.

Contract Amount: \$233,280

Contractor Project Manager: Erik Kolderup, 415) 957-1977

Commission Contract Manager: Virginia Lew, (916) 654-3838

Project Description: The purpose of this project is to develop reference specifications for specific energy-efficiency equipment or technologies for commercial buildings. The focus is on equipment and technologies that are cost effective to install but for which information is inadequate. This project is envisioned to remove the barriers toward specifying energy efficient equipment and technologies for commercial buildings by:

- Simplifying the specifications of some technologies;
- Addressing project commissioning and monitoring within each of the technologies;
- Providing specifications for advanced cost-effective technologies;
- Addressing integrated controls and open protocols for commercial lighting and heating, ventilating and air conditioning (HVAC) systems; and
- Disseminating the new specifications to the industry through the Internet.

Once the specifications have been tested by the Contractor's team and reviewed by building design professionals, they will be made available through the Internet. The format will facilitate the use and incorporation of the specifications into construction documents by design professionals. In addition, equipment manufacturers will also understand what they need to build to satisfy the efficiency market.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by influencing standard construction practices and future building and system energy use in the commercial sector.

Proposed Outcomes:

- Promote energy efficient design of commercial buildings through actual use of the developed specifications.
- Reduce annual building system (e.g., lighting, HVAC)

energy costs of the building whose design used the specifications by at least five percent.

Project Status: The project is on schedule and is within budget. The project is expected to be completed by March 31, 2004.

Project Title: DESIGN REFINEMENT AND DEMONSTRATION OF A MARKET-OPTIMIZED RESIDENTIAL HEAT-PUMP WATER HEATER

Contract #: 500-98-028

Contractor and Major Subcontractors: Arthur D. Little, Inc. and EnviroMaster International; Manufacturing Associates; Pacific Plumbing.

Contract Amount: \$756,095

Match Funding: \$109,235

Contractor Project Manager: Robert A. Zogg, (617) 498-6081

Commission Contract Manager: Tony Wong, (916) 654-4015

Project Description: The purpose of this project is to design, test and demonstrate a market-optimized residential heat-pump water heater. The primary objectives of this project are to identify and implement design refinements to lower initial and operation costs and increase performance, perform laboratory tests to demonstrate the durability/reliability of the design, and demonstrate the performance, reliability and ease of installation through a California-based field test.

A.D. Little will provide durability testing on three prototypes for one year under laboratory conditions and will field-test 25 prototype units in California residences.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by providing a low-cost, highly reliable and durable residential heat-pump water heater (HPWH).

Proposed Outcomes:

- Reduce the total installed cost of residential heat pump water heaters from \$1,200 to \$875.
- Design and fabricate a heat pump water heater capable of achieving at least a 2.0 energy factor, the standard performance measure for water heaters using a test procedure prescribed by the U.S. Department of Energy.

Project Status: The project is on schedule and within budget.

Project Title: REMOVING THE KEY TECHNICAL BARRIER TO THE WIDESPREAD USE OF ADVANCED ABSORPTION COOLING

Contract #: 500-98-029

Contractor: Gas Research Institute with Stanford Research Institute (SRI) and The Trane Company.

Contract Amount: \$690,178

Match Funding: \$235,000

Contractor Project Manager: Kevin Krist, (773) 399-8211

Commission Contract Manager: Bradley Meister, (916) 653-1594

Project Description: The goal of this project is to improve the efficiency and lower the cost of natural gas fired absorption chillers. This project will study and support continuing development of new corrosion resistant materials, applied as a thin diffusion coating on low cost materials of a commercial air conditioning system that uses an advanced absorption chiller. After diffusion coatings are selected, generator and absorber components will be tested in individual sub-scale absorption chiller components and a sub-scale advanced absorption generator machine.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing the demand on the electrical system during summer peak hours; and
- Improving the environmental and public health costs/risks of California's electricity by using an absorption cycle that does not use CFCs nor any material with ozone depletion, global warming or health hazard potential.

Proposed Outcomes:

Coefficient of Performance (COP) goal:	Up to 1.6
Temperature limits:	Up to 285 degrees C (545 degrees F)
Heat transfer rate goal:	Same thermal conductivity as the base material
Materials lifetime goal:	20 years
Corrosion goal:	01 mpy
Coating cost goal:	<\$10/ft ² for generators < \$3/ft ² for absorber heat exchangers

Project Status: Project is on schedule and is within budget. The project is expected to be completed by March 31, 2004.

Project Title: IMPROVING ENERGY EFFICIENCY OF COMMERCIAL KITCHEN EXHAUST SYSTEMS

Contract #: 500-98-031

Contractor and Major Subcontractors: Pacific Gas and Electric Company (PG&E) and Electric Power Research Institute (EPRI); Fisher Consultant; Architectural Engineering Corp.; International Facility Management Association.

Contract Amount: \$276,165

Match Funding: \$225,000

Contractor Project Manager: Grant Brohard, (925) 866-5713

Commission Contract Manager: Tony Wong, (916) 654-4015

Project Description: The goal of this project is to improve the energy efficiency of commercial kitchen ventilation systems by performing flow-visualization research of a variety of ventilation systems and publishing design guidelines for the food service industry.

The project will test wall-mounted, canopy-style hoods with parametric (fixed limit or boundary) makeup air configurations, island-mounted, canopy-style hoods with parametric makeup air configurations and backshelf-style hoods with parametric makeup air configurations. The project will create methods, standards and tools available for use by all manufacturers and ratepayers. The project will also expand the data base on kitchen ventilation system efficiency, providing purchasers with energy efficient options while encouraging manufacturers to raise the base efficiency of a given hood style. The results of this project will equally benefit all commercial food service ventilation equipment manufacturers and commercial food service owners and operators.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by providing more energy efficient methods for ventilating commercial kitchens.

Proposed Outcomes:

- Demonstrate how introduction of makeup air can improve energy efficiency of Underwriters Laboratories (UL)-listed commercial kitchen hoods by 40 percent.
- Recommend to the American Society for Testing and Materials (ASTM) use of schlieren flow visualization system technology for the ASTM F 1704-96 Standard Test Method for Performance of Commercial Kitchen Ventilation Systems.
- Contribute information for possible updates to heating, ventilation and air conditioning (HVAC) design manuals by

the American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) on commercial kitchen ventilation systems, using makeup air.

- Publish comprehensive design guidelines for commercial kitchen ventilation systems.
- Provide objective, visual information and analytical software on commercial ventilation equipment performance to help food service operators make informed decisions about exhaust hood design, sizing and energy efficiency.

Project Status: The project is on schedule and on budget, and is expected to achieve proposed outcomes.

Project Title: NEXT-GENERATION POWER MANAGEMENT USER INTERFACE FOR OFFICE EQUIPMENT

Contract #: 500-98-032

Contractor and Major Subcontractors: Lawrence Berkeley National Laboratory (LBNL).

Contract Amount: \$449,841

Contractor Project Manager: Alan Meier, (510) 486-4740

Commission Contract Manager: Joseph Wang, (916) 654-4026

Project Description: The purpose of this project is to develop and assess energy-efficient power management interface standards adaptable to a variety of office equipment and appliances used in commercial buildings. Electricity savings from the power management of office equipment has been one of energy efficiency's premier success stories. Despite this success, many devices that are capable of power management are not saving energy because the power management features are disabled, incorrectly configured, or thwarted by a hardware or software conflict. The goal of this project is to capture energy savings by increasing the rate at which power management is enabled and operates successfully.

Technical challenges include identifying interface elements that people find the clearest and simplest, and a system which meets the needs of all manufacturers. The U.S. DOE and the U.S. EPA have, through the Energy Star Program, committed their institutional resources to ensuring the active participation of industry. However, the standard will be voluntary – no company will be required to use it – and can be adhered to entirely or partially by manufacturers. This approach allows gaining the benefits of a standard while retaining flexibility for manufacturers that believe that they

can improve on the interface, or have a product with unique or unanticipated features.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by improving the energy efficiency of commercial-sector office equipment and appliances.

Proposed Outcomes:

- Design, develop and test a new, standard user interface for office equipment power management which is acceptable to electronic equipment manufacturers, standards organizations and the U.S. EPA's Energy Star program for voluntary adoption.

Project Status: Contract agreements have not been reached with LBNL..

Project Title: INSTRUMENTED HOME ENERGY RATING AND COMMISSIONING

Contract #: 500-98-033

Contractor: Lawrence Berkeley National Laboratory (LBNL)

Contract Amount: \$710,000

Match Funding: \$137,000

Contractor Project Manager: Max Sherman, (510) 486-4022

Commission Contract Manager: Dale Trenchel, (916) 654-4098

Project Description: The purpose of this project is to demonstrate the energy savings that building commissioning services would have on new and existing residences in California, laying the groundwork for a residential commissioning industry to provide these services. The energy performance of the most significant components of a building will be evaluated, and the diagnostics and audit tools developed will be for use in commissioning. Commissioning guidelines for new and existing homes will also be developed and efforts will be undertaken to reach building, service, utility and regulatory representatives with the results.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by helping consumers optimize the energy systems in their home to perform at peak energy efficiency and ensuring that the results are connected to the market by making use of a project advisory committee with participants from the building industry, home energy rating professionals, utilities and government.

Proposed Outcomes:

- Develop commissioning guidelines for new and existing houses.
- Undertake outreach efforts to the buildings, services, regulatory and professional communities to ensure that the guidelines are appropriately utilized.

Project Status: Contract agreements have not been reached with LBNL.

Project Title: INVESTIGATION OF SECONDARY LOOP SUPERMARKET REFRIGERATION SYSTEMS

Contract #: 500-98-039

Contractor and Major Subcontractors: Southern California Edison and Foster-Miller.

Contract Amount: \$300,000

Match Funding: \$150,000 (Safeway/Vons Inc.)

Contractor Project Manager: Ramin Faramarzi, P.E., (626) 633-7168

Commission Contract Manager: Nelson R. Peña, (916) 654-4217

Project Description: The purpose of this project is investigate the use of an advanced secondary loop system that will circulate a refrigerated brine solution from a chiller to refrigeration equipment display cases in supermarkets. The project will identify possible system improvements such as variable-speed pumping, evaporative condensing, sub-cooling and low-head pressure operation that will reduce

energy consumption in supermarkets. The existing refrigeration equipment display cases in an existing supermarket will be instrumented to measure baseline performance. A second new store, using an advanced secondary loop system, will also be instrumented, and a field test of both systems will be conducted where performance and energy consumption of each system will be compared. The secondary loop refrigeration systems can significantly reduce the refrigerant charge in supermarkets, which promotes substantial environmental benefits by protecting the ozone layer and inhibiting global warming.

This project supports the PIER Program objectives of:

- Improving environmental and public health costs/risk of California's electricity by developing an alternative refrigeration system, which uses significantly less ozone-depleting refrigerant than conventional refrigeration systems; and
- Improving the energy cost/value of California's electricity by lowering electrical consumption of supermarket secondary loop refrigeration systems.

Proposed Outcomes:

- Reduce energy consumption for refrigeration or freezing in supermarkets by approximately 13.9 percent.

Actual Outcomes: The project is ahead of schedule and under budget. Work is expected to be complete by April 4, 2002.

Industrial/Agricultural/Water End-Use Energy Efficiency Program Area**Project Title: INTEGRATED AGRICULTURE TECHNOLOGY**

Contract #: 500-97-012-03

Contractor and Major Subcontractors: Edison Technology Solutions

Contract Amount: \$320,000

Contractor Project Manager: Lory Larson

Commission Contract Manager: Ricardo Amon

Project Description: This project demonstrated the use of ozone as a substitute soil fumigant; ozone as an alternative to aqueous toxic chemicals for fungi control in fruit packing

plants; low-temperature, controlled-ventilation in storage facilities; innovative manure treatment technologies; and irrigation scheduling systems.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by increasing the efficiency of emerging electrotechnology applications in agriculture and improving the environment, and
- Improving the public health costs/risks of California's electricity by replacing toxic chemicals with cleaner electrotechnologies in the fruit industry.

Proposed Outcomes:

- Determine the effectiveness of ozone as a preplant soil fumigant to destroy a variety of soil-borne microorganisms.
- Determine the effectiveness of ozone as a disinfectant and fungicide in aqueous solutions used for fruit storage and packaging operations and ozone treatment for discharge water quality purposes.
- Determine the effectiveness of ozone as a post-harvest fumigant to control insect infestation of fresh and dried fruits and vegetables.
- Demonstrate the viability and practicality of a low-cost, temperature-controlled storage facility to inhibit insect infestation of stored fruit. Test the effectiveness of plastic film bin liners to control insects in stored prunes. Develop baseline data on Indianmeal moth populations near drying and storage facilities.
- Determine the functionality of an innovative biological treatment device to manage the disposal of liquefied animal wastes.

Actual Outcomes:

- Ozone treatment demonstrated substantial improvements and crop yield or plant vigor compared to untreated controls in all crops tested except peaches. Soil treatment with ozone decreased soil pathogens and increased nutrient availability.
- From 95 to 100 percent of all eight fungi tested were killed in two minutes of contact time with the ozone treatment. None survived three minutes of contact. Higher doses of ozone were required to kill pathogens on fruit surfaces than those needed to kill spores in water. Ozone significantly reduced gray mold incidence on table grapes, but its efficacy was irregular. Ozone was inferior to sodium hypochlorite, sodium bicarbonate, and ethanol as a fungicide. The control of pathogens inoculated into wounds in citrus fruit failed even after prolonged treatment with very high ozone concentrations in water.
- Table grapes, citrus fruit, and strawberries were not visibly injured by the ozone treatments evaluated. In strawberry wash water, ozonation for three hours greatly reduced microbe populations, moderately reduced biochemical oxygen demand, chemical oxygen demand, and suspended solids; did not reduce total organic carbon; and increased total dissolved solids.
- Four to six hours of exposure to ozone concentrations of 300 to 500 parts per million were needed to kill Indianmeal moth larvae and diapausing codling moths. Chambers designed for ozone fumigation will need to be made of

materials that can withstand the corrosive action of continuous exposure to high concentrations of ozone. Therefore, results of this first phase are preliminary and more research is required.

- The controlled ventilation and evaporative cooling system was too expensive to install, considering it would only provide safe storage temperatures for seven months of the year. Prune quality was determined to be excellent after one year in storage in plastic bags. Moisture content of the prunes did not change during storage, and the fruit was exceptionally free of sugaring and mold compared to fruit stored conventionally. Bins with liners must be stored in an environment that prevents significant diurnal temperature fluctuations. Baseline data collected indicated that Indianmeal moth is the species of most concern for prune storage. The liner storage system will work well only if fruit is virtually free of infestation before being placed in the liners.
- The sequencing batch reactor was determined an effective biological reactor for treating dairy wastewater. A two-stage sequencing batch reactor system is recommended over a single-stage system if nitrification is desired. The two-stage system was capable of achieving near-complete conversion of ammonia to nitrite and nitrate in the dairy wastewater.

Project Title: LOW DROSS ALUMINUM MELTER PROJECT

Contract #: 500-97-012-02

Contractor and Major Subcontractors: Edison Technology Solutions (ETS) and TIMCO, Division of TST, Inc.; Paul Wurth, Inc.

Contract Amount:	\$450,000
Match Funding:	\$2,650,000
Southern California Edison:	\$1,950,000
EPRI:	\$300,000
DOE NICE3:	\$400,000

Contractor Project Manager: Mazen Sadeq, (626) 815-0513

Commission Contract Manager: Dennis K. Fukumoto, (916) 653-6222

Project Description: The purpose of this project was the demonstration of an advanced DC-Arc Plasma furnace designed to melt aluminum scrap material for the reuse market within a controlled, oxygen-starved environment that prevents the formation of aluminum oxide (dross) and reduces the volume of process waste material.

This project supports the PIER Program objectives of:

- Improving the energy cost and value of California's electricity by demonstrating a technology that increases energy efficiency by 80 percent for recovering scrap aluminum for reuse; and
- Improving the environmental and public health costs/risks of California's electricity by demonstrating a technology that yields the following advantages over gas-fired reverberatory furnaces.

Proposed Outcomes: The objective of this project was to design, fabricate, and place into operation a five-ton DC Plasma Arc melter that meets typical commercial melting requirements of the scrap aluminum recycling industry by:

- Upgrading the one-ton Wabash unit and apply various lessons and design improvements gained from the experimental operation of that unit.
- Demonstrating the commercial viability of the DC Plasma-Arc melting technology for the aluminum reprocessing industry.
- Design and build a five-ton unit at a commercial site.

Actual Outcomes:

Design requirements for modification of the Wabash unit were prepared by the Technical Team under the direction of ETS. The Wabash upgrade activities included:

- Tightening of furnace seals to lower dross formation.
- Design of a mechanical stirring capability.
- Relocation of furnace electrodes to increase furnace efficiency.
- Improve furnace feed system to increase throughput and reliability.
- Develop dross removal techniques that reduce O&M costs.
- Demonstrate conversion of dross into useful steel-making additive.
- Optimize the refractory practice, argon flowrate, furnace temperature and process cycle times.

Project Title: UV PRINTING ON PLASTICS

Contract #: 500-97-012-04

Contractor: Edison Technology Solutions

Contract Amount: \$250,000

Contractor Project Manager: Mazen Sadeq,
(626) 815-0513

Commission Contract Manager: Ellie Townsend-Smith

Project Description: The goal of this project was to develop and test a six-color ultraviolet (UV) commercial printing system as an affordable and energy-efficient alternative to traditional solvent-based ink printing process.

Project Status: This project was cancelled before beginning Phase II after the owner of the printing facility withdrew from the project, taking \$100k in match funding and leaving ETS without a facility to perform the research.

Project Title: LABORATORY-TYPE FACILITIES

Contract #: 500-97-013-07

Contractor and Main Subcontractor: California Institute for Energy Efficiency (CIEE) and Lawrence Berkeley National Laboratory (LBNL).

Contract Amount: \$375, 000

Contractor Project Manager: Carl Blumstein,
(510) 642-9590

Commission Contract Manager: Clinton Lowell Jr.,
(916) 654-4554

Project Description: The purpose of this project was to provide new technology and applications knowledge to reduce the energy intensity and improve the performance of high-tech and laboratory-type facilities. Facilities of this type frequently house cleanrooms. Examples of California industries where high-tech manufacturing and research-type facilities exist are semiconductor, electronic, biotechnology, pharmaceutical, aerospace, medical and universities.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by improving the energy efficiency of an ever-growing sector of California's industry.

Proposed Outcomes:

- Develop a new fume hood that reduces airflow requirements.
- Develop a systems approach to airflow design criteria and tools that optimize fan power consumption.
- Complete field studies on HVAC technologies.
- Develop guidelines for energy efficient laboratory design, and
- Refine an existing computer-based analysis tool that facilitates a systems-oriented approach to cleanroom design.

Actual Outcomes: The project is on schedule and within budget.

Project Title: RECYCLING CHILLER-BATH RINSE WATER IN POULTRY PROCESSING

Contract #: 500-98-030

Contractor and Major Subcontractors: WaterTech Partners

Contract Amount: \$440,400

Match Funding: \$144,000

Contractor Project Manager: Ronald Enzweiler, (925) 283-4918

Commission Contract Manager: Ricardo Amon, (916) 654-4019

Project Description: The goal of this project is to reduce the energy required in poultry processing by demonstrating the feasibility of using ozone water treatment technology to recycle chiller bath rinse water in poultry processing operations. Presently, poultry processors use chlorine chemicals to disinfect the chiller-bath step and must discard the 0.5 gallons of chilled, chlorinated rinse water used per bird to meet USDA sanitary regulations.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity to electric ratepayers by reducing energy use or improving energy efficiency in the industrial sector; and
- Improving the environmental and public health costs/risks of California's electricity by avoiding the use of chlorine disinfectants.

Proposed Outcomes: Using the Mobile Treatment Demonstration Unit (MTDU) provided by EPRI, a feasibility test at the Foster Farms Poultry Processing Plant in Livingston, California will:

- Demonstrate that ozone is an effective antimicrobial sanitizer in poultry processing which can be safely used in direct contact with the birds and that ozone does not create any harmful by-products or side effects.

Upon obtaining U.S. Department of Agriculture (USDA) approval for a pilot-test program, WaterTech partners will

- Design, install and operate a closed-loop, ozone-based pilot recycling system at a Petaluma, California poultry processing chiller line for six months. Successful pilot-scale testing is expected to result in USDA approval for replacing chlorine with ozone in the chiller-bath process of the poultry-processing industry.
- Achieve energy savings by returning the filtered and disinfected chiller-bath overflow water to the heat exchanger used to chill water for the chiller bath. Since the average temperature of the feed water will be reduced to about 50 degrees F from 75 degrees F, the refrigeration load will be dramatically reduced which will lower overall system energy requirements.
- Achieve estimated net energy savings of three million kWh per year of energy (about 12 watts/bird) in the 250-million-bird-per-year poultry processing industry in California.

Project Status: MTDU tests were conducted and documentation and results were submitted to the U.S. Food and Drug Administration (USFDA) for approval to conduct pilot test at a commercial facility. The project was granted approval by the USFDA and the U.S. Department of Agriculture (USDA) and will begin construction of pilot test facility by the end of 1999.

Renewable Energy Technologies Program Area

Project Title: PHOTOVOLTAIC (PV) CHARGEPORT DEMONSTRATION

Contract #: 500-97-011-03

Contractor: San Diego Gas & Electric Company (SDG&E)

Contract Amount: \$90,000

Contractor Project Manager: Sally Wirsching,
(619) 654-8269

Commission Contract Manager: Jamie Patterson,
(916) 657-4819

Project Description: The purpose of this project was to demonstrate the integration of electricity-generating photovoltaic (PV) panels into a covered parking port to charge electric vehicles. This application of PV will illustrate how the panels can be integrated into the current electrical system for practical applications.

This project supports the PIER Program objective of:

- Improving the environmental and public health costs/risks of California's electricity by providing a clean source of electricity for zero-emission vehicles.

Proposed Outcomes:

- Establish guidelines for future deployment of PVs for electric vehicle charge stations without the need for extensive engineering.

Actual Outcomes:

- This project demonstrated that photovoltaics can be integrated with electric vehicle chargeports to partially offset the amount of electricity used to charge electric vehicles.

Project Title: PHOTOVOLTAICS

Contract #: 500-97-012-11

Contractor and Major Subcontractors: Edison Technology Solutions and Utility PhotoVoltaic Group (UPVG); U.S. Department of Energy (USDOE); Emerging Renewables.

Contract Amount: \$1,000,000

Match Funding: \$1,427,000

Contractor Project Manager: Steve E. Taylor,
(626) 815-0530

Commission Contract Manager: Jamie Patterson,
(916) 657-4819

Project Description: The purpose of this project was to operate and monitor twelve photovoltaic (PV) systems to evaluate their year-round system performance and efficiency. This evaluation was to document that photovoltaics are applicable on a wide scale to the typical building types located in the dense urban areas of Southern California.

This project supports the PIER Program objectives of:

- Improving the environmental and public health costs/risks of California's electricity by documenting the application of a clean electrical generation technology; and
- Improving the reliability/quality of California's electricity because PV offers an attractive, environmentally benign renewable energy alternative for distributed electrical generation.

Proposed Outcomes:

- Support Edison Technology Service's (ETS) Solar Neighborhood Program by helping to commercialize photovoltaic technology, educate and increase public awareness, and deploy photovoltaics into high-value, high-visibility applications by evaluating system performance and efficiency as compared to expected results, and evaluating the seasonal effects of year-round PV operations in California.

Actual Outcomes:

- Properly designed and situated PV systems were shown to operate within 15 percent of their expected system efficiency specifications.
- The seasonal effects of the various PV systems showed that with increasing panel temperatures, efficiencies decreased. Conversely, when the panels were cooler at the same irradiance level, system efficiency increased. Increasing daylight hours in the summer increased overall energy production. The decreased panel efficiency occasioned by increased summer temperatures was more than offset by longer daylight hours. Peak power reduction was offset by increased energy production.

Project Title: SOLAR TWO

Contract #: 500-7-012-10

Contractor: Southern California Edison

Major Subcontractors: Bechtel International and Boeing Corporation; Rocketdyne Division

Contract Amount: \$1,200,000

Match Funding: \$52,880,000

Match Funding Participants:

Bechtel International: \$3,095,000
Boeing Company, Rocketdyne Division, and other Industry: \$1,888,000
Electric Power Research Institute: \$1,750,000
Southern California Edison: \$10,516,000
Los Angeles Department of Water and Power: \$1,261,000
South Coast Air Quality Management District: \$100,000
PacificCorp: \$1,261,000
Arizona Public Service and Salt River Project: \$1,261,000
Idaho Power: \$1,261,000
Nevada Power: \$100,000
Chilean Nitrate Corporation: \$1,000,000
U.S. Department of Energy: \$24,250,000
Other Contributors: \$2,615,000

Contractor Project Manager: Bill Stoke, (909) 394-8986

Commission Contract Manager: Alec Jenkins, (916) 654-4597

Project Description: This project completes the testing and evaluation of the 10 MW Solar Two Central Receiver Project. Solar Two uses concentrated solar energy to produce steam for electric generation. It is a proof-of-concept power plant that demonstrates the practical combination of the solar central receiver concept and the use of molten salt as an efficient, nontoxic heat transfer and energy storage fluid. The central receiver/molten salt design is presently the only practical technology for collecting and storing solar thermal energy for electric generation on demand, whether that demand is hours or days after the energy has been collected.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by using a sustainable energy resource to diversify the State's electricity supply system;
- Improving the energy cost/value of California's electricity by overcoming the intermittent nature of traditional solar electric generation so that even baseload power can be provided;
- Improving the environmental and public health costs/risks of California's electricity by using a zero emission generation technology with a nontoxic energy storage medium (molten salt); and
- Improving the safety of California's electricity by using a nonflammable energy transfer fluid (molten salt).

Proposed Outcomes:

- Test and validate the technical characteristics including performance of the nitrate salt receiver, energy storage system, and steam generator subsystems; and generation dispatch capability.
- Improve the accuracy of economic projections for commercial projects by increasing the database for capital, operating, and maintenance costs.
- Document overall project results for use by public and private R&D programs and the solar industry to foster wider interest in commercial plants.

Actual Outcomes:

- Completed all primary tests and data collection goals, including demonstrating full operational flexibility and successful operation of an advanced receiver panel technology.

Specific Technical Outcomes:

- Gross turbine output as a function of heat input to the steam generator agreed well with design estimates.
- The efficiency of the molten salt receiver agreed well with design predictions.
- The energy storage subsystem fully met efficiency predictions.
- Between July 1 and July 7, 1998, the plant demonstrated a key advantage of the molten salt central receiver by delivering 24-hour a day continuous solar-electric power to the grid (153 hours). The project has therefore demonstrated full dispatch capability.
- Improved the accuracy of economic projections by obtaining actual performance data for use in scaling the design performance prediction model, Solergy.
- Improved plant cost predictions by documenting refinements in operation and maintenance procedures and expected outcomes in cost and performance, as well as design and operational refinements to be incorporated in the subsystems for commercial plant.
- SunLab (the solar thermal program collaboration between the National Renewable Energy Laboratory) is documenting the overall project results for use by public and private R&D programs and the solar industry to foster wider interest in commercial plants.

**Project Title: POWERTHERM, A PHOTOVOLTAIC/
THERMAL HYBRID COMMERCIAL ROOFING SYSTEM**

Contract #: 500-97-046

Contractor and Major Sub-Contractors: Powerlight Corporation and Advanced Thermal Technologies, Inc.; Sealed Air Corp.; Kathabar Inc.; David Roodvoets.

Contract Amount: \$542,362

Match Funding: \$1,052,361

DOE PV Bonus: \$781,354

Commercial project

contributors: \$271,007

Contractor Project Manager: Tom Dinwoodie,
(510) 540-0550

Commission Contract Manager: Arnold Ward,
(916) 657-4630

Project Description: This purpose of this project is to test a commercial photovoltaic/rooftop solar energy collector system providing electric power and thermal energy from sunlight. The integration of a solar-thermal component with the Contractor's PowerGuard[®] photovoltaic system will create a hybrid photovoltaic/thermal (PV/T) system, called PowerTherm[™]. This technology is suitable for buildings with flat to moderately sloping roofs and will increase the economic value of PV roof-tile systems for commercial building owners by providing them with two ways to lower their energy utility costs: PV-electrical generation and solar hot-water production for on-site use.

The PowerGuard[®] product was substantially advanced under a product R&D contract with the Commission's Energy Technologies Advancement Program and has been successfully tested in dozens of applications internationally. PowerGuard[®] incorporates state-of-the-art PV technology with extruded foam backing into roofing tiles. These tiles, or panels, are electrically connected to an inverter that feeds quality AC Power to the building's electrical system at or near peak load demand periods for electricity suppliers. This technology can be integrated into new and re-roofing projects, or readily applied over existing roofs.

This project contributes to the PIER program objective of:

- Improving the reliability/quality of California's electricity system by developing a distributed-energy technology; and
- Improving environmental and public health cost/risks of California's electric system by deploying a renewable energy source that does not emit nitrous oxides, sulfur oxides, and carbon dioxide when generating electricity.

Proposed Outcomes:

- Introduce a cost-effective PowerTherm[™] product to commercial and residential building owners.
- Improve heat transfer between the PV laminate and solar-thermal absorber by 40 percent (from .5 to .7 Btu/hour per foot per degrees F.).
- Increase the effective irradiance of the sloped collector by 5 percent.
- Increase the thermal performance of the overall system by 35 percent.
- Improve the overall system efficiency by 45 percent.
- Achieve a net (thermal-only) system production tile cost of \$6 per square foot.
- Achieve a thermal component payback of less than five years in specified markets.

Project Status: This project is on schedule and within budget.

**Project Title: RESIDENTIAL ELECTRIC POWER
SECURITY**

Contract #: 500-97-047

Contractor and Major Subcontractor: Utility Power Group (UPG) and Southwest Technology Development Institute; and New Mexico State University.

Contract Amount: \$426,343

Match Funding: \$994,799

Contractor Project Manager: Michael Stern,
(818) 700-1995

Commission Contract Manager: Shahid Chaudhry,
(916) 654-4858

Project Description: The purpose of this project is to design, assemble, and test a photovoltaic (PV) power system for residential rooftop applications. The project will focus on three aspects of the system. In the first part, UPG will design, assemble, and test a novel rooftop PV panel attachment and interconnection process. The second part will produce a fully integrated multifunctional dc-ac/ac-dc power collection, conversion, and control unit. A third focus will be an optional low-cost battery unit designed to plug into the Power Unit to provide a dependable supply of energy for critical household loads.

The proposed PV power system will possess features such as low cost, high efficiency, adaptable to a wide range of roof tops, high power quality, and compliance with all NEC, UL, IEEE, and Utility Interconnection Codes and Standards. The developed system is expected to reduce the installed cost of grid connected PV by approximately 34 percent, and improve their reliability by a factor of five.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by increasing reliability over current systems from 10 percent rate of failure to 2 percent rate of failure (a five fold improvement); and
- Improving the energy cost/value of California's electricity by optimizing design of residential roof-mounted PV through a system integration approach, increase system modularity to reduce manufacturing costs, and develop standardized hardware and methods for PV/roof attachment to reduce installation costs.

Proposed Outcome:

- Develop an advanced version of the multi-functional rooftop PV power processing system with a number of market driven advanced capabilities which do not exist in any commercially available power processing product. Contractor anticipates reducing materials and installation costs (exclusive of the PV module) by 30 percent.

Project Status: The project is ahead of schedule and within budget. The term of this contract expires on March 31, 2002. UPG, however, plans to complete this contract by December 31, 2000. It is expected that this contract will achieve the proposed outcome.

Project Title: DEVELOPMENT OF AN EXTENDED INDUCTION LOGGING TOOL FOR GEOTHERMAL EXPLORATION AND FIELD DEVELOPMENT

Contract #: 500-97-034

Contractor and Major Subcontractors: ElectroMagnetic Instruments, Inc. and Lawrence Livermore National Laboratory.

Contract Amount: \$565,735

Match Funding: \$814,964

Contractor Project Manager: Michael Wilt, Ph.D., (510) 232-7997

Commission Contract Manager: Pablo Gutiérrez S., (916) 654-4663

Project Description: The purpose of this project is to design, manufacture and field test an extended induction logging device for geothermal applications in California. During the 2 1/2 year project, hardware and software for a high temperature and pressure tolerant logging tool will be developed and tested in several field trials in California and eventually internationally.

This device will provide a three dimensional image of the formation resistivity in the vicinity of a geothermal borehole. It can identify electricity conductive regions associated with high temperature fluids and map through-going fractures, which play a crucial role in fluid production.

The decline of power generation at the Geysers from a peak capacity of 1,600 MW to current production of less than 800 MW emphasizes the need for improved reservoir management. This phenomenon is a result of 1) a poor understanding of the fracture system that controls production, recharge and the movement of injected fluids, 2) insufficient recharge from all water sources, and 3) over-production and/or less than optimal injection.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by providing a tool that can determine fracture orientation and map formation resistivity that can lead to better understanding systems fracture, thus, improving reservoir management by optimizing field production and coordinating recharge;
- Improving the energy cost/value of California's electricity by including the establishment of new logging services and the enhancement of geothermal energy exploration; and
- Improving the environmental and public health costs/risks of California's electricity by developing an environmentally benign renewable energy source.

Proposed Outcomes:

- Provide for the design and construction of instrumentation that will provide technological solutions to several important problems in geothermal exploration and field development.
- Provide improved reservoir definition and fracture mapping in geothermal boreholes. This will better define drilling targets and reduce the number of boreholes required to produce adequate steam for power generation.

Project Status: The project is on schedule and within budget.

Project Title: HYBRID SOLAR-FOSSIL THERMOPHOTOVOLTAICS

Contract #: 500-97-048

Contractor and Major Subcontractors: EDTEK and Brookhaven National Laboratory; Power Management Systems, Inc.; The Charters Group, Inc.; NML Partnership; Pacific Financial Group.

Contract Amount: \$867,945

Match Funding: \$1,917,107

Contractor Project Manager: W. Ed Horne, (253) 395-8084

Commission Contract Manager: Prab Sethi, P.E., (916) 654-4509

Project Description: The purpose of this project is for EDTEK, Inc. to design, fabricate and test a modular, hybrid solar/fossil-fueled thermophotovoltaic (SFTPV) system that can produce electricity and process grade hot water 24 hours per day with a recovery efficiency of about 83 percent. In this system, highly concentrated sunlight is directed into a cavity where the surrounding walls are heated to incandescence, the state where visible light is emitted from a hot object. A natural gas flame is also directed into the cavity to heat its walls and excite the PV cells, as does the concentrated sunlight.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by developing a new distributed generation technology; and
- Improving the environmental and public health costs/risks of California's electricity through partial use of solar energy, a renewable and non-polluting energy source.

Proposed Outcomes: Develop, manufacture and demonstrate a pre-production hybrid prototype SFTPV cogeneration power system that can produce economically competitive electric power and thermal energy on a 24-hour basis. The SFTPV power system will convert sunlight to electricity with 25 percent overall efficiency, and natural gas to electricity at an overall efficiency of 20 percent while producing process grade hot water at a recovery efficiency of 83 percent.

Project Status: The project term is to March 31, 2002. The project is on schedule and within budget.

Project Title: POWERWHEEL DEMONSTRATION PROJECT

Contract #: 500-97-037

Contractor and Major Subcontractor: PowerWheel Associates and Ideal Electric Co.; Electrical Maintenance Consultants; Granger Engineering Services; N. J. Mccutchen, Inc.; ERC, Inc.; California State University, California Polytechnic Institute, San Luis Obispo; Johnson's Building Inspection Service.

Contract Amount: \$200,000

Match Funding: \$200,000

Contractor Project Manager: Kenneth Broome, (650) 529-1810

Commission Contract Manager: Shahid Chaudhry, (916) 654-4858

Project Description: This purpose of this project is to prove the technical, economic, and environmental suitability of the PowerWheel technology for converting energy from low-head waterfalls into cost-competitive electricity. A 75 kW PowerWheel will be demonstrated in an irrigation canal and the electricity generated by it will be distributed to nearby agricultural, industrial, commercial, and residential customers through an interconnection with the electricity grid.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity as it is expected that electricity from this source will be more reliable than wind and solar energy;
- Improving the energy cost/value of California's electricity by providing electricity at a lower cost than conventional hydroelectricity costs; and
- Improving the environmental and public health costs/risks of California's electricity by displacement of electricity generated by combustion processes resulting in the reduction of exhaust gases of about 250 tons/kW/year of PowerWheel installations. In addition, PowerWheel installations will have no adverse impacts on water quality and may enhance the dissolved oxygen content of the water.

Proposed Outcome:

- Prove the full-scale technical, economic, and environmental suitability of PowerWheel technology for conversion of the presently wasted renewable energy available in very low-head waterfalls into electricity.

Project Status: The project is behind schedule because the contractor must find another host site for the PowerWheel demonstration. One PowerWheel unit is ready for installation and demonstration. Because of poor cost analysis for the manufacturing of one demonstration unit, and design

revisions, the manufacturing cost of the demonstration unit was significantly higher than initially estimated. Consequently, the tasks budget had to be reallocated. The contractor will provide the additional in-kind services to meet the increased cost of the project. It is expected that this contract will achieve the proposed outcome.

Project Title: POWER PV SYSTEM ADVANCED MANUFACTURING DEVELOPMENT AND SCALE-UP

Contract #: 500-97-049

Contractor and Major Subcontractors: PowerLight Corporation and Pulse Energy Systems; Trace Technologies; Colorado State University; Augustyn and Company; T. Clear Engineering; Feldman, Waldman and Klein; Solarex; Ananda Power Technologies; Sandia National Labs.

Contract Amount: \$958,991

Match Funding: \$1,994,421

\$998,977 NREL

\$50,000 Trace Engineering

\$532,734 New York State Power Authority

\$412,710 Various commercial project contributors

Contractor Project Manager: Tom Dinwoodie,
(510) 540-0550

Commission Contract Manager: Arnold Ward,
(916) 657-4630

Project Description: The purpose of this project is to expand grid-connected markets for PowerGuard® systems by reducing component and system manufacturing costs, enhancing system reliability, and obtaining specific certifications. PowerGuard® is a roof-top photovoltaic (PV) system providing electrical power. Furthermore, this project will establish a new California manufacturing facility, using the automated and semi-automated fabrication innovations developed under this contract.

This project supports the PIER Program objectives of:

- Improving the reliability of California's electricity system by developing a renewable, distributed-energy technology;
- Improving the environmental and public health costs/risks of California's electricity by deploying a renewable energy source which does not emit NOx (nitrous oxides), SOx (sulfur oxides), and CO2 (carbon dioxide) when generating electricity; and
- Positively impacting California's economy by creating new manufacturing jobs.

Proposed Outcomes:

- Reduce PowerGuard® system costs and improve system reliability through advanced fabrication equipment, which will automate or semi-automate system component manufacturing, thereby increasing production capacity and reducing labor costs.
- Develop PowerLight's in-house capability to fabricate PowerCurb housings (Powercurb is the array perimeter securement of the PV panels and contains and secures the outer perimeter of the PV panels to the roof. Powercurbs are used in retrofit applications over an existing roof).
- Ensure that PowerGuard® systems, as modified under this contract, will continue to receive certifications from specific independent testing and certification entities.
- Reduce PowerGuard® PV roof top system costs to create cost-effective PV systems, which will not need subsidies after 2002.
- By semi- or fully automating many aspects of PowerGuard® system manufacturing, reduce unit costs to \$3.05 per peak watt.
- Reduce the cost of the PowerGuard® RT PowerCurb to \$4 per linear foot.
- Increase Component Reliability Objectives.
- Meet performance criteria for the Trace Technology's grid-tied inverter control board with a calculated Mean Time Between Failures of 59,000 or greater.
- Construct a 5,000 square foot or greater "Cell-to-System" manufacturing facility in California which includes an automated PowerGuard® Tile Fabrication line that is capable of yielding 400 tile substrates per day throughput.
- Assure that PowerGuard® manufacturing meets all applicable NEPA, OSHA and building code requirements.
- Establish allowable building heights for PowerGuard® system installations.
- Obtain Underwriters Laboratory (UL), International Conference of Building Officials (ICBO), and international certifications for PowerGuard® systems.

Project Status: This project is on schedule and within budget.

Project Title: NEXT GENERATION WIND TURBINE DEVELOPMENT PROJECT

Contract #: 500-97-032

Contractor and Major Subcontractors: The Wind Turbine Company (WTC)

Contract Amount: \$950,000

Match Funding: \$6,935,733

U.S. Department of Energy (NREL): \$4,463,226

Wind Turbine Company: \$2,472,505

Contractor Project Manager: Robert Poore,
(206) 292-0070

Commission Contract Manager: Michelle Pantoya, Ph.D.,
(916) 653-4128

Project Description: The purpose of this project is to design, develop and demonstrate a utility scale wind turbine that will produce electricity at prices that do not need subsidies or premiums to compete in the emerging electricity marketplace. Rated at 350 kilowatts, this turbine is a horizontal axis, 2-blade, downwind turbine that brings together a number of concepts previously employed in other turbines of this design. In addition, this turbine is the first 2-blade downwind configured wind turbine to be developed in over 15 years, and is believed to be the first turbine to be completely designed employing newly available computer analytic codes that model wind turbine behavior and performance. By designing the turbine as a complete system, WTC is able to substantially improve turbine performance while significantly reducing weight compared with conventional wind turbines. Reducing weight lowers manufacturing costs which, together with improved performance leads directly to lower cost electricity. This machine will be well suited for both grid-connected, wind farm applications and for stand alone applications in combination with other generating and/or energy storage technologies.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by increasing the likelihood that wind energy will not only remain a viable source of renewable electricity, but will actually supply a growing share of the electricity consumed in the state;
- Improving the energy cost/value of California's electricity by developing a wind turbine capable of producing electricity at prices competitive with the lowest cost sources of conventional electricity generation, currently recognized to be natural gas-fired combined-cycle combustion turbines;
- Improving the environmental and public health costs/risks of California's electricity by reducing air pollution and eliminating emissions that are believed to cause global warming; and

- Improving the safety of California's electricity by employing a unique tubular tower design of sufficient diameter to provide an internal passage from the ground to the tower top (nacelle).

Proposed Outcomes:

- Bringing to market readiness a utility scale wind turbine that is cost competitive with other sources of energy generation.
- Developing and field testing of a proof of concept wind turbine intended to demonstrate the feasibility of concepts and systems employed in the wind turbine, and to validate the computer codes used in design the turbine through testing.
- Developing of a prototype turbine that is intended to be a commercially saleable machine.
- Producing a commercial product that provides renewable, clean, reliable and cost competitive energy.
- Reduce capital costs due to weight reductions in key turbine components.
- Produce electricity for 3.5 cents/kWhr or less when installed in annual quantities of 100 units or more in wind farms featuring wind resources at 15 mph.

Project Status: Project is on schedule and within budget. Project is expected to achieve proposed outcomes.

Project Title: NATURAL GAS COFIRING IN BIOMASS BOILERS

Contract #: 500-97-040

Contractor and Major Subcontractors: Gas Research Institute (GRI) and ARCADIS Geraghty & Miller; Coen Company; Burney Mountain Power; Fairhaven Power Company.

Contract Amount: \$655,702

Match Funding: \$732,736

Contractor Project Manager: Dr. Robert Gemmer,
(773) 399-8313

Commission Contract Manager: Dr. Valentino Tiangco,
(916) 654-4664

Project Description: The purpose of this project is to develop and retrofit low NOx gas cofire technology on two biomass fired industrial power boilers at Burney Mountain Power and Fairhaven Power. With biomass, the high fuel moisture level and high fuel quality variability reduce electric competitiveness and increase environmental compliance

costs. By firing small amounts of gas, approximately 10 percent of total heat input, operators can control the combustion process and avoid the usual problems that accompany combustion of wet biomass. Cofire offers an independently controlled combustion zone with higher temperatures, resulting in faster load response, better CO and opacity burnout, reduced carbon in the ash, and faster, cleaner startup. These benefits are essential for biomass to compete in the volatile deregulated power market that requires greater responsiveness than is now possible.

In this project, GRI will subcontract the low NOx burner development to the cofire burner developer, Coen. The low NOx burner will retain the high-pressure drop feature used earlier, but employs segmented gas/air zones and possibly inspirated combustion gas dilution. The prototype burner will be installed in two northern California biomass power plants: Burney Mountain Power and Fairhaven Power. At Burney, cofire will allow recovery of lost derate and allow peak revenue load dispatch to effectively meet changing power demand. At Fairhaven, cofire will recover lost derate and allow compliance with CO and NOx regulations.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by developing a method for improving the economics of grid-connected, distributed electricity generating biomass facilities;
- Improving environmental and public health costs/risk of California's electricity by mitigating air quality impacts from biomass combustion by cofiring biomass with natural gas within an independently controlled combustion zone with high-temperature, turbulent mixing. The low NOx feature is unique to California, and this demonstration should facilitate cofire permitting at other biomass facilities; and
- Impacting local and state economies by preserving employment opportunities in rural areas where these biomass facilities are typically located.

Proposed Technical Outcomes:

- Develop a low NOx cofire burner for application to biomass fueled boilers.
- Apply the low NOx cofire burner to increase the load following capability and turndown for Burney Mountain Power.
- Apply the low NOx cofire burner to reduce CO emissions and recover lost derate with wet wood at Fairhaven Power.

Proposed Economic/Cost Outcomes:

- Apply cofiring at Burney Mountain Power to capture high revenue power peaks and avoid low revenue periods to

allow operation in the deregulated power market and reduce the break-even power price.

- Apply cofiring at Fairhaven Power to recover lost derate with wet wood and accrue incremental power sales revenue over the differential fuel price.

Project Status: The contract between GRI and the State of California was signed December 29, 1998. Contracts with the principal subcontractors - ARCADIS Geraghty & Miller, and Coen - have been signed. The project is on schedule and within budget.

Project Title: DESIGN AND OPTIMIZATION OF A SOLAR-FIRED DOUBLE-EFFECT ABSORPTION CHILLER

Contract #: 500-97-035

Contractor and Major Subcontractors: Bergquam Energy Systems and Richard Christensen, Ohio State University; Sun Utility Network; Thermal Energy Systems Specialists; Instructional Systems.

Contract Amount: \$150,000

Match Funding: \$150,000

Contractor Project Manager: Dr. Jim Bergquam, (916) 383-9425

Commission Contract Manager: Prab Sethi, P.E., (916) 654-4509

Project Description: This purpose of this project is to optimize the performance of a solar-fired double-effect absorption chiller, which can be used for space cooling of small to medium-sized commercial buildings. In addition, the project will modify and test the solar-fired chiller to determine generator configuration and operating conditions that maximize chiller and system performance.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing electrical consumption during peak demand created by cooling commercial buildings;
- Improving the energy cost/value of California's electricity by replacing packaged, compressor-based air conditioning systems with a lower-cost solar absorption system; and
- Improving the environment and public health of California's electricity by replacing CFCs in compression air conditioners with environmentally safe lithium bromide and water as the working fluid in a solar-driven absorption chiller.

Proposed Outcomes:

- A high-efficiency, double-effect absorption chiller that is optimized for coefficient of performance (COP), cooling capacity and operating temperature. The chiller will be driven by solar collectors. The chiller will have a coefficient-of-performance (COP) in the range of 1.2 to 1.4, when the first stage generator is operated at high temperature (approximately 3000 degrees F). The chiller will have a COP in the range of 1.1 to 1.2, when the first stage generator is operated at low temperature (below 2500 degrees F).

Project Status: The project is on schedule and within budget.

Project Title: POWER CONDITIONING UNIT (PCU) TEST CENTER AT PVUSA

Contract #: 500-097-050

Contractor and Major Subcontractors: SMUD and Endecon Inc.

Contract Amount: \$374,847

Match Funding: \$140,800

Contractor Project Manager: Dan Whitney, (916) 732-5351

Commission Contract Manager: Jamie Patterson, (916) 657-4819

Project Description: The goal of the Power Conditioning Unit (PCU) Test Center project is to establish a test center to evaluate the performance and operational limits/criteria of Power Conditioning Units used for photovoltaics (PV) and other distributed resource technologies connected to distribution systems. PCUs, also known as static power inverters, convert and condition the electricity generated by these technologies so that it can be safely and effectively used in grid-connected distribution systems.

This project supports the PIER Program objective of:

- Improving the safety of California's electricity by developing and implementing test procedures that verify the performance and operational limits/criteria for PCUs.

Proposed Outcomes:

- A test center to evaluate the performance and operation of Power Conditioning Units (inverters).

Project Status: The project is on schedule and within budget.

Project Title: UTILIZATION OF WASTE RENEWABLE FUELS IN BOILERS WITH MINIMIZATION OF POLLUTANT EMISSIONS

Contract #: 500-98-037

Contractor and Major Subcontractor: GE Energy and Environmental Research Corporation; University of California, Davis; T.R. Miles Consultants; Stanford University.

Contract Amount: \$981,952

Match Funding: \$610,238

Contractor Project Manager: Dr. Vladimir Zamansky, (949) 859-8851

Commission Contract Manager: Dr. Valentino Tiangco, (916) 654-4664

Project Description: The purpose of this project is to develop an innovative technology, Close-Coupled Gasification (CCG), which is a synergistic combination of direct combustion, biomass/waste gasification, and GE/EER's emission control approaches to be applied in existing California biomass boilers. The CCG technology focuses on bringing renewable energy, energy supply reliability, energy price stability, and protection of the environment to the California marketplace. The CCG technology will also help to solve the existing problems of the biomass power industry in California. The continued survival of the biomass power industry greatly depends on the expansion of availability of diverse, low-cost fuel sources, and this project develops specific feedstocks to be used in combined combustion/gasification mode.

The goal of this project is to develop a preliminary conceptual design for a full-scale demonstration facility of CCG technology. The design would retrofit (couple) CCG technology in a California biomass power plant to reduce NOx emissions by using gasified, low-grade biomass/waste fuel. This project is Phase I of a four-phase CCG technology commercialization plan. If analyses prove that the project would be technically and economically feasible, the project developers may decide to design, retrofit and operate the demonstration facility (Phases II and III) and to commercialize the technology throughout California and elsewhere (Phase IV).

This project supports the PIER Program objectives of:

- Improving the environmental and public health risks/costs of California's electricity by developing a lower-cost method for existing biomass power plants to control NOx and other pollutant emissions.

- Maximizing market connection for the project's research results. Specifically, three California biomass power plants, which are potential partners in the full-scale CCG technology demonstration, will participate in this project's design and economic studies to determine if the technology will provide economic and operational benefits to their units.

Proposed Outcomes:

Specific Technical Outcomes:

- Design and development of an economic process (demonstration facility), which is capable of converting biomass/waste into gaseous fuel to be used as supplementary cofiring/reburning fuel and NOx control in California biomass boilers.
- Produce 10-30 percent of gaseous fuel (by heat input) for a 25 MW biomass boiler;
- Reduce NOx emissions up to 65 percent in basic reburning and 90 percent in advanced reburning (AR); and complying with all other California emissions standards.

Specific Economic Outcome:

- Reduce NOx control costs by at least 20 percent, compared to the costs of existing NOx control methods used by biomass boilers owned by Wheelabrator Shasta/Hudson Energy Company, Woodland Biomass, and Wadham Energy.

Project Status: Work on Task 2.1 (Assessment of California Waste and Biomass Resources for Gasification) was initiated by conducting an initial search for information on waste fuel types, amount, composition, availability, and cost. The search encompassed review of various biomass Internet sites, including Western Regional Biomass Energy Program, DOE, NREL (Biomass Resource Informational Clearinghouse), and Oak Ridge National Lab. Additional work on Task 2.1 was done, including compiling literature studies for various waste streams, and contacting industry trade groups and suppliers to evaluate current waste availability, handling practices and costs.

Work on Task 2.2 (Laboratory Scale Gasification Screening Experiments), to be conducted at the University of California, Davis, was initiated. This included preparing the kick-off meeting presentation focussing on research task approach, laboratory equipment, experience and capabilities. Additionally, the UC Davis group started preparations for the fluidized bed reactor to be used in Task 2.2.

Preliminary preparations for Task 2.3 (Kinetics of Biomass and Waste Particles Gasification/ Reburning) were also conducted by the Stanford University group. This included

preparing the kick-off meeting presentation (Titled: Characterizations of the Behaviors of the Chars of Biomass and Waste-Derived Fuels under Reburning Conditions) which explained the approach planned for performing the research task. This included explaining the theory and presenting the facilities at Stanford University. Preparatory laboratory work was also conducted including testing and repairing equipment where necessary, and in some instances, improving upon some equipment for the Commission project. Additionally, some tests have been performed on various synthetic chars to validate the "Mode of Char Particle Burning Model" intended to be utilized in the Commission project.

The project kick-off meeting was held at the Marriott hotel in Oakland, California, during the Fourth Biomass Conference of the Americas on August 30, 1999. The Commission Contract Manager (Dr. Valentino Tiangco), GE/EER's representatives (Dr. Vladimir Zamansky and Dr. George Rizeq), and subcontractors' representatives (including UC Davis, Stanford University, T.R. Miles, EPRI, Battele, Wadham Energy Limited Partnership, and SDV-EERGC) attended the meeting.

Project Title: COLLINS PINE COGENERATION PROJECT

Contract #: 500-98-043

Contractor and Major Subcontractors: Collins Pine Company and BC International (BCI); National Renewable Energy Laboratory (NREL); Plumas Corporation; Kemestrie; TSS Consultants; ProForma Systems, Inc.; Tembec Inc.; Raphael Katzen Associates International Inc.; CIFAR.

Contract Amount: \$1,148,961

Match Funding: \$375,274

Contractor Project Manager: Jack Siverstson, (503) 227-1219

Commission Contract Manager: Dr. Valentino Tiangco, (916) 654-4664

Project Description: This purpose of this project is to determine the technical and economic feasibility of integrating a new biomass-to-ethanol facility with an existing biomass power plant, located in Chester, California. If feasible, these two facilities would be operated together and become customers for each other's products. The ethanol facility would produce lignin for sale to the biomass boiler, which it would use to generate electricity and steam. In addition, the biomass power plant would generate electricity and steam for sale to the ethanol facility. This project seeks to lower the biomass power plant's electricity-generating

costs so that it can become more cost-competitive after subsidies for renewable energy power plants expire in 2004. The lignin fuel supply from the ethanol facility may help to lower the biomass power plant's costs of generating electricity. The ethanol facility would also generate income by producing and selling ethanol and other value added co-products to customers outside of Chester. The project is Phase I of a four-phase effort. If the results of Phase I are technically and economically positive, then facility developers may proceed with subsequent phases to design, permit, finance, construct and operate the ethanol facility.

This project supports the PIER Program objective of:

- Improving system reliability and power quality of California's electricity by seeking a cost-effective way to operate a distributed generation power plant in a rural area, which is prone to electricity supply disruptions. The project also contributes to the PIER program objective of providing positive impacts to a California local economies by the creation of new jobs and new tax revenues in a rural area.

Specific Technical Outcomes:

- Determine whether the ethanol facility can produce up to 20 million gallons per year of ethanol from softwood feedstock using BCI technologies;
- Determine whether lignin from the ethanol facility can partially displace the existing fuel of Collins Pine biomass power plant by 30 percent to 60 percent; and

- Identify at least one co-product, other than lignin or ethanol, which can be produced by the ethanol facility

Specific Economic Outcomes:

- Reduce the cost of electricity production at the Collins Pine biomass power plant by at least 1.5 cents/kWh, and
- Identify at least one co-product, other than lignin or ethanol, which can be produced by the ethanol facility, which has a value of at least \$2/pound.

Project Status: The project kickoff meeting was held June 14, 1999, at the University of California, Davis. Initial data collection was initiated regarding the historical annual National Forests. Assessment of the feedstock economics for the hauling distance to Chester, California has also began. Ethanol brokers have been contacted and the history and current price of ethanol has been reviewed. A simulation model of ethanol distillation is being developed using ChemCAD software. Environmental information and data on previous industrial facilities sited in Plumas and other Northern California areas have been gathered. Collins Pine and BCI are presently working on subcontract issues. The project is on schedule and within budget.

Environmentally Preferred Advanced Generation Program Area

Project Title: DISTRIBUTED RESOURCES DEMONSTRATION

Contract #: 500-97-011-04

Contractor: San Diego Gas & Electric Company (SDG&E)

Contract Amount: \$450,000

Contractor Project Manager: Al Figueroa, (619) 654-8614

Commission Contract Manager: Jamie Patterson, (916) 657-4819

Project Description: The goal of this project is to demonstrate how small distributed generation systems can be seamlessly integrated into existing electric distribution systems. Distributed generation will allow additional electric generation facilities to be installed without undertaking construction of large commercial power plants and will provide backup for the current electrical distribution system.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by improving the integrity, reliability and safety of California's energy supply system through diverse distributed electrical resources. In addition, this project addresses electrical distribution issues raised by deregulation of the California electricity industry.

Proposed Outcomes:

- Studies for defining standards for the interconnection of distributed energy resources.
- Remote dispatching and control strategies for distributed energy resources will be examined.

Actual Outcomes: The equipment for this project is currently being installed and tested.

Project Title: FUEL CELL DEVELOPMENT AND DEMONSTRATION

Contract #: 500-97-011-02

Contractor and Major Subcontractors: San Diego Gas and Electric (SDG&E)

Contract Amount: \$300,000

Contractor Contract Manager: Al Figueroa, (619) 654-8614

Commission Contract Manager: Dr. Avtar Bining, (916) 657-2002

Project Description: The purpose of this project is to demonstrate the performance and reliability of a molten carbonate fuel cell (MCFC) electric generating technology with upgraded system components. Proving the efficiency and effectiveness of fuel cells will help propel this low-emission, electric generation technology into the marketplace. This project will assist in the advancement of MCFC technology by providing labor and selected materials for modifying the existing balance-of-plant (BOP) components designed for a 250 kW capacity MCFC demonstration plant at the Marine Corps Air Station Miramar. Balance-of-plant modifications are required to accept the next generation fuel cell stack having a capacity of 75 kW. An improved design of MCFC fuel cell stacks will be tested and demonstrated at the Miramar plant. Other system components, including a new hot gas blower and turbo charger, will also be tested. Additionally, an assessment of the technical feasibility of integrating micro-turbine generator technology with the MCFC technology will be done.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by offering energy efficient, low-emission alternate sources of electricity that diversify the State's electrical generation resources.

Proposed Outcomes:

- A modified BOP suitable to accept M-C Power's 75 kW MCFC stack.
- Testing and evaluation of a new hot gas blower and turbocharger for a reliable performance.
- Assessment of technical feasibility of integrating micro-turbine technology with the MCFC technology.

Actual Outcomes:

- The project resulted in a modified reliable BOP suitable for accepting the M-C Power's 75 kW MCFC stack.

- New hot gas blower and turbocharger units were tested and evaluated. The new units have been found very reliable during the BOP testing and subsequent 75 kW MCFC stack testing. The system has been continuously operating for nearly 3000 hours.
- Assessment has revealed very favorable prospects of integrating the micro-turbine technology with the MCFC technology.

Project Title: SOLID-OXIDE FUEL CELL/MICRO TURBINE GENERATION HYBRID

Contract #: 500-97-012-07

Contractor and Major Subcontractors: Edison Technology Solutions and Siemens-Westinghouse/Northern Research Engineering Corporation (NERC); University of California, Irvine (UCI); Energy Systems Services Corporation; Paragon.

Contract Amount: \$2,000,000

Match Funding: \$14,900,000

Contractor Project Manager: John Leeper, (626) 815-0512

Commission Contract Manager: Dr. Avtar Bining, (916) 657-2002

Project Description: The purpose of this project is to demonstrate proof-of-concept testing for integrating two dissimilar electricity producing distributed generation technologies – pressurized solid oxide fuel cell (PSOFC) and micro turbine generator (MTG) – into a 250kW hybrid unit. This project will support Edison Technology Solutions' (ETS) participation in a \$16.9 million public/private sector collaborative project with the U.S. DOE, Siemens Westinghouse and the University of California, Irvine (UCI), where the technology will be demonstrated. This project will demonstrate a "first of a kind integration" of both technologies. While both technologies are separately nearing commercialization, their integration into a hybrid unit is expected to offer significant environmental and energy efficiency benefits. Further, it is expected that the mature, commercial hybrid units will be more competitive than stand-alone fuel cells and will provide the same level of clean power output. Successful completion and utilization of this technology will result in air quality benefits through a reduction in NOx and greenhouse gas emissions. The integrated pressurized fuel cell and MTG hybrid will result in a 60 percent electrical efficiency-generating device that is equal to or greater than any other form of fossil-energy generation.

This project supports the PIER Program objective of:

- Improving the energy cost/value and improving environmental and public health costs/risk of California's electricity by providing reliable, diverse, energy-efficient, low-emission distributed electrical resources.

Proposed Outcomes:

- Develop, test and demonstrate a Solid-Oxide Fuel Cell/Micro Turbine Generation Hybrid distributed power generation technology.

Project Status: Development of solid oxide fuel cell stack and micro-turbine was delayed due to developmental problems. The contract term has been extended until December 2000.

Project Title: MICRO-TURBINE GENERATOR (DISTRIBUTED GENERATION)

Contract #: 500-97-012-08

Contractor and Major Subcontractors: Edison Technology Solutions and University of California, Irvine (UCI); Energy System Services Corp.; CAMS; Paragon; Capstone Turbine Corporation; Bowman Turbines, Inc.

Contract Amount: \$500,000

Match Funding: \$1,500,000

Contractor Project Manager: Stephanie Hamilton, (626) 815-0514

Commission Contract Manager: Dr. Avtar Bining, (916) 657-2002

Project Description: The purpose of this project is to test small gas turbines in distributed electrical generation applications. This project is part of a public/private sector \$2 million collaborative microturbine generator (MTG) transition procurement and testing project at the University of California, Irvine (UCI). The project partners include UCI, U.S. DOE, EPRI, and several MTG manufacturers.

This project will procure and test, for the first time, small gas turbine technology in distributed generation applications. The MTG collaborative program consists of extrapolating the automotive MTG design into a long-life machine suitable for use as a land-based electric generation technology. The PIER Program's transition project funding will fund the procurement and testing of two Bowman microturbine generators, a major element of this program. The MTG, which is typically rated in the 30-60 kW range, is a small combustion turbine that has an integral high-speed generator.

This project supports the PIER Program objectives of:

- Improving the reliability/quality and the energy cost/value of California's electricity by offering alternatives for distributed generation applications that will reduce the costs of transmitting and distributing electricity;
- Improving environmental and public health costs/risk of California's electricity by reducing NOx emissions from on-site electrical generation; and
- Impacting local and state economy by contributing information to help in developing an emerging distributed generation technology industry in California.

Proposed Outcomes:

- Enhance system reliability - MTGs can enhance system reliability benefits for California utility ratepayers by reducing T&D operating costs.
- Reduced NOx emissions.
- Economic Development –Procure MTGs from two California-based MTG manufacturers. If successful, this project will contribute information to help in developing an emerging distributed generation technology industry in California.

Actual Outcomes:

- Two Bowman (35 kW and 60 kW) and a Capstone 28 kW were tested. The Bowman 35 kW operated for 100.6 hours, the Bowman 60 kW operated for 4.2 hours and the Capstone 28 kW operated for 1,879 hours. Both Bowman units operated on a sporadic basis due to component failures and operational restrictions imposed by unacceptably high noise levels. The Capstone micro-turbine operated within the manufacturer's claimed efficiency rating at full load.
- The Bowman 35 kW emissions test data could not be obtained due to unacceptable technical conditions. However, both the Bowman 60 kW and the Capstone 28 kW units emissions test showed NOx and CO levels that met or were well below limits set by the SCAQMD.
- The Capstone 28 kW unit's power quality measurements met the Institute of Electronics Engineering's standard for harmonic control in electric power systems. The Bowman units provided for testing require additional enhancements in order to improve operability and reliability. Further testing of MTGs is required to test the validity of the manufacturers claims and to determine if they can become a vital part of the State's electrical generating capacity mix.

Project Title: LOW NOX GAS TURBINE COMBUSTORS FOR DISTRIBUTED POWER GENERATION

Contract #: 500-97-031

Contractor: Alzeta Corporation

Contract Amount: \$878,788

Match Funding: \$675,000

Contractor Project Manager: Dr. Scott Smith,
(408) 727-8282

Commission Contract Manager: Dave Hatfield, P.E.,
(916) 654-7119

Project Description: The purpose of this project is to continue development of the Gas Turbine Semi-Radiant Burner (GTSB) for gas turbine applications. The outcome product for this project is an integrated design incorporating the core GTSB technology with the control and hardware interfaces necessary for application to one or more commercially available gas turbine engines.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by reducing the cost for NOx mitigation and reduction technology for small- and micro-scale gas turbines; and
- Reducing environmental and public health costs/risk of electricity generation in California by achieving greater emissions reductions than currently required by law.

Proposed Outcomes:

- Simultaneous reduction of NOx and CO emission to less than 2 ppm (15 percent O₂) without any post combustion exhaust clean up.
- Expected cost on par with original equipment combustors.
- Eliminate the need for Selective Catalytic Reduction (SCR) on gas turbines in non-attainment areas.

Project Status: The project is on schedule and within budget.

Project Title: DURABILITY OF CATALYTIC COMBUSTION SYSTEMS

Contract #: 500-97-033

Contractor: Catalytica Combustion Systems, Incorporated.

Contract Amount: \$1,316,303

Match Funding: \$3,029,846

Contractor Project Manager: Tom Morjig, (650) 940-6371

Commission Contract Manager: Michelle Pantoya, Ph.D.,
(916) 653-4128

Project Description: The purpose of this project is to conduct the research and development necessary to advance catalytic combustion technology for on-engine field testing in a 1.5 MW Kawasaki (KHI) gas turbine engine. The technology must have demonstrated high durability and reliability for fast market acceptance. To accomplish this goal, Catalytica will operate the currently developed Kawasaki combustor in a power generation facility for 8000 hours (one year). In addition, Catalytica will continue the rapid development of the technologies required to obtain the necessary durability and reliability for the KHI combustor and catalyst module. Once reliability has been demonstrated, the Kawasaki combustor will be moved to commercial sites for field-testing. Finally, the Kawasaki combustor will be offered as a commercial product and begin translation of the technology to other gas turbine engines. The project goal is to improve energy cost and value of California's electricity market by creating a cost-competitive alternative to conventional NOx mitigation and reduction technologies for gas turbines in all size ranges.

This project supports the PIER Program objectives of:

- Improving the reliability and quality of California's electricity by eliminating harmful pollutants and allowing gas turbines, which offer higher reliability compared to the current generating fleet, to compete in a deregulated market;
- Improving the energy cost/value of California's electricity by introducing catalytically-fired, industrial scale gas turbines that will decrease the cost of electricity compared to the higher cost option of these gas turbines equipped with post-combustion treatment systems such as selective catalytic reduction; and
- Improving the environment and public health risks of California's electricity by incorporating a pollution prevention rather than a pollution clean-up technology that is potentially more effective at reducing NOx and CO emissions by eliminating them from formation during combustion.

Proposed Outcomes:

- Bring to market readiness a catalytic combustion system that is cost competitive with other commercially available NOx reduction technologies for industrial-scale gas turbines.
- Lab test the catalytic combustion system under actual engine service conditions to validate the adequacy of all components of the design and to establish durability during an 8000-hour performance test.
- Computation fluid dynamics (CFD) studies of the fuel-air

mixer system that will improve the design by improving performance and reducing cost for the final commercial engine.

- Lab test to determine the effect of variability in gas fuel composition on catalyst performance.
- Produce a commercial product that provides cost effective NOx control that meets permitting requirements in the most restrictive air quality districts. The catalytic combustion system resulting from this project will have a lower capital than selective catalytic combustion systems for the engines with comparable NOx control.

Project Status: The project is on schedule, within budget, and is expected to achieve proposed outcomes.

Project Title: A NOVEL STEAM REFORMING REACTOR FOR FUEL CELL DISTRIBUTED POWER GENERATION

Contract #: 500-97-038

Contractor and Major Subcontractor: Energy and Environmental Research (EER) and Phillips Petroleum Company.

Contract Amount: \$349,852

Match Funding: \$303,457

Contractor Project Manager: Jerald Cole, (949) 859-8851

Commission Contract Manager: Shahid Chaudhry, (916) 654-4858

Project Description: The goal of this project is to advance the technology of distributed power generation using fuel cells by developing a novel steam reforming process to convert fossil fuels to hydrogen. The process promises to advance fuel cell technologies that are being hampered by the lack of hydrogen distribution and production systems. Specifically, under this project, EER will develop and evaluate extended life catalysts and sorbents and apply their discoveries to a refined reactor design for advancing the steam reforming process. The key technical issues to be addressed by this project are developing catalysts with extended lifetimes and optimizing the use of these catalysts in the process.

This project supports the PIER Program objective of:

- Improving the reliability/quality, improving the environmental and public health costs/risks and improving the energy cost/value of California's electricity by advancing the use of low-emission, low-cost, distributed resource fuel cell technologies.

Proposed Outcome:

- Develop and evaluate catalysts and sorbents and apply

their discoveries to a refined reactor design for advancing the steam reforming process.

- Develop catalysts with extended lifetimes and optimizing the use of these catalysts in the process.
- Design and build a prototype-reforming unit. The proposed effort will fill in a missing link in a broader program currently underway with support from DOE.

Project Status: The project is behind schedule due to a discovery that some potentially more durable catalysts experienced secondary reactions that inhibited performance. The project is on budget, and the project is expected to achieve the proposed outcome.

Project Title: 75-KW MOLTEN-CARBONATE FUEL CELL (MCFC) STACK VERIFICATION TEST

Contract #: 500-97-039

Contractor and Major Subcontractors: M-C Power Corporation and San Diego Gas and Electric; Bechtel National, Inc.; Alternative Energy Systems Consultants; and Stewart and Stevensen.

Contract Amount: \$1,000,000

Match Funding: \$1,956,841

Contractor Project Manager: Thomas Benjamin, (630) 986-8040, Ext. 159

Commission Contract Manager: Dr. Avtar Bining, (916) 657-2002

Project Description: The purpose of this project is to demonstrate the energy-producing performance of advanced design molten carbonate fuel cell (MCFC) stack components in a 75 kW electric power generator. The 75 kW MCFC Stack Verification Test Project is an important step toward commercializing MCFC power generation technology in the year 2002. The test will be conducted at the existing test facility at Marine Corps Air Station Miramar in San Diego. Based on information from a prior Miramar test and small-scale factory tests, advances in fuel cell components and stack design have been identified. A new 75 kW stack will be built incorporating the advanced technology and will be installed at Miramar for testing. The test program participants include the U.S. Department of Energy, the California Energy Commission, San Diego Gas & Electric, and M-C Power, Incorporated.

This project supports the PIER Program objectives of:

- Improving environmental and public health costs/risk of California's electricity by developing an efficient electric generating technology that emits negligible levels of ozone

and smog precursor pollutants and reduced levels of carbon dioxide; and

- Improving the reliability/quality of California's electricity by demonstrating fuel cell technology for distributed generation applications.

Proposed Outcomes:

- Verify the long term current density performance of M-C Power's most advanced stack design in full size cells under field conditions.
- Evaluate the effect of anode recycle on generator performance.
- Gather operating data upon which to base the design of future commercial prototype generators.
- 50-80 percent higher efficiency than conventional combustion-type generators.
- Negligible emissions of ozone and smog precursor pollutants.
- Reduced production of carbon dioxide exceeding target of climate change initiatives.
- Higher reliability of service – high-quality power, few moving parts and no transmission lines; reduced consumption of fuel resources; and competitive cost of electricity.

Project Status:

- M-C Power, Inc. successfully completed nearly five months of testing of its integrated, pressurized molten carbonate fuel cell (MCFC) power plant technology.
- Testing took place at M-C Power's system verification test facility at the Marine Corps Air Station (MCAS) Miramar in San Diego, California. Performance operations of a new improved design 75 kW stack, associated systems and components were initiated on July 4, 1999 and continued until the end of November 1999.
- The MCFC power plant operated for about 3,300 hours and generated 250 MWh of electricity. The power system generation consistently exceeded the 75 kW rating throughout the test period.
- Nitrogen oxide emission levels were below 0.4 ppm, which verified significant environmental benefits of MCFC technology.
- System performance exceeded expectations and provided valuable design and operating information which is essential for the design of a commercial unit. The commercial unit will be ready for testing in 2001.

- This test demonstrated the viability of M-C Power's pressurized power plant concept. It is a major step forward toward the market introduction of MCFC power plants in 2002.

Project Title: ENERGY EFFICIENT, LOW EMISSION, COST EFFECTIVE MICROPILOT IGNITED NATURAL GAS ENGINE DRIVEN GENSET FOR DEREGULATED, DISTRIBUTED POWER GENERATION MARKETS

Contract #: 500-97-041

Contractor and Major Subcontractors: Gas Research Institute, Chicago, IL and BKM, Inc., San Diego, CA

Contract Amount: \$982,528

Match Funding: \$250,000

Contractor Project Manager: Lou Lautman, (773) 399-8100

Commission Contract Manager: Shahid Chaudhry, (916) 654-4858

Project Description: The purpose of this project is to develop a new technology which takes advantage of the cost and emissions benefits of clean burning natural gas, the fuel efficiency of modern diesel engines, the low first cost of high production diesel engines, and the ease of installing distributed power with an internal combustion engine. This technology is known as MicroPilot diesel cycle natural gas engine.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by making lower cost, more reliable and better quality electrical power available via distributed generation where it is not possible to do so under central power generation approaches;
- Improving the energy cost/value of California's electricity by providing expected energy cost under \$0.04/kWhr and installed cost under \$200/kW; and
- Improving the environmental and public health costs/risks of California's electricity because there is no known or suspected adverse impacts to the environment, citizens' health or safety resulting from this project or the commercialization of this technology.

Proposed Outcome:

- Complete development of a 1 percent MicroPilot engine.
- Demonstrate a production ready version of the MicroPilot technology applied to the very popular Caterpillar 3412

diesel generator set engine. The MicroPilot technology developed and demonstrated under this project will be offered to Caterpillar (and all other OEM manufacturers) for commercialization.

Project Status:

The project is late by about five months due to late delivery of one of the engines for use in this project. The discussion for reducing this delay is underway. The term of this contract expires on March 31, 2002. GRI, however, plans to complete this contract by December 31, 2000. The project is on budget and is expected to achieve the proposed outcome.

Project Title: ULTRA HIGH EFFICIENCY PACKAGED MICROCOGENERATION SYSTEM

Contract #: 500-97-042

Contractor: AeroVironment Inc.

CEC Funding: \$1,035,420

Match Funding: \$ 425,319

The proposed project was to develop and demonstrate a proof-of-concept in a new paradigm of microcogeneration turbine system, called space-heating microcogeneration, based on a low cost 10 kW combustion turbine generator (Quickturbine). AeroVironment was awarded a PIER-1 contract on the assumption that their Quickturbine would be ready in time to be used in the PIER contract.

Project Status: This project was cancelled after a major participant withdrew and an independent evaluation by Dynatech recommended that the engine be redesigned. It was determined that the time necessary for redesign was not appropriate for extending the project's term.

Project Title: MEGAWATT-CLASS PRESSURIZED SOLID OXIDE FUEL CELL/GAS TURBINE POWER SYSTEM DEMONSTRATION PROJECT

Contract #: 500-97-045

Contractor: Westinghouse Electric Company

Contract Amount: \$550,000

Match Funding: \$550,000

Contractor Project Manager: Dr. Stephen E. Veyo, (412) 256-1901

Commission Contract Manager: Prab Sethi, P.E., (916) 654-4509

Project Description: The goal of this project was to prepare the preliminary design for a megawatt-class

pressurized, solid-oxide fuel cell/gas turbine power system for generating electricity at commercial and small industrial sites.

Project Status: A 250 kW fuel cell/gas turbine project was previously awarded to Edison Technical Solutions (ETS) under the Transition Funding Solicitation. The testing of the ETS project was delayed. The test information was required from the 250 kW project to start the Westinghouse project. This information was not available; therefore, the Westinghouse project was cancelled.

Project Title: CATALYTIC COMBUSTOR-FIRED GAS TURBINE FOR DISTRIBUTED POWER AND COGENERATION APPLICATIONS

Contract #: 500-98-041

Contractor and Major Subcontractor: Solar Turbines, Incorporated and Catalytica Combustion Systems, Incorporated; University of California, Irvine.

Contract Amount: \$814,543

Match Funding: \$773,391

Solar Turbines: \$427,700

Catalytica: \$345,691

Contractor Project Manager: Kenneth Smith, Ph.D., (619) 544-5539

Commission Contract Manager: Michelle Pantoya, Ph.D., (916) 653-4128

Project Description: The purpose of this project is to develop the necessary component technologies and complete engineering design of a multi-can catalytic combustion system suitable for application in two gas turbines, the Taurus 60, rated at 5.2 MW, and the Centaur 50, rated at 4.6 MW. The system will be designed for 5-ppm NOx emissions without the use of water or steam injection or the use of any post-combustion NOx reduction. This project is the first of three phases of development. Phase two will conduct hot testing of the combustor assembly. Phase three will test the combustor in actual operation on a gas turbine.

This project supports the PIER Program objectives of:

- Improving the reliability and quality of California's electricity by eliminating harmful pollutants and allowing these gas turbines, which offer higher reliability compared to the current generating fleet, to compete in a deregulated market;
- Improving the energy cost/value of California's electricity by introducing catalytically fired industrial scale gas turbines that will decrease the cost of electricity compared

to the higher-cost option of these gas turbines equipped with post-combustion treatment systems such as selective catalytic reduction (SCR); and

- Improving the environment and public health cost/risks of California's electricity by incorporating a pollution prevention rather than a pollution clean-up technology that is potentially more effective at reducing NOx and CO emissions by eliminating them from formation during combustion.

Proposed Outcomes:

- Bring to market readiness, a catalytic combustion system that is cost competitive with other commercially available NOx reduction technologies for industrial scale gas turbines.
- Lab test to develop and then integrate the optimum preburner, premixer, catalytic core and burn out zone liner designs into the Centaur 50 and Taurus 60 gas turbines.
- Implement a control system strategy for the catalytic combustion system capable of handling start-up, shutdown, load following, and full load loss without damage to the combustor or gas turbine.
- Produce a commercial product that provides cost effective NOx control that meets permitting requirements in the most restrictive air quality districts.
- Capital cost over eighty percent less than selective catalytic combustion systems for the Taurus and Centaur gas turbines with comparable NOx control. This will result from completion of this three-phase project.

Project Status: The project is on schedule, on budget, and is expected to achieve proposed outcomes.

Interagency Project Title: EXPAND AND UTILIZE THE CAPACITY OF THE NATIONAL FUEL CELL RESEARCH CENTER PROGRAM

Contract #: 500-98-051

Agency Partners: University of California, Irvine; Southern California Edison; M-C Power; Siemens-Westinghouse/NREC; Energy Systems Services Corp.

Contract Amount: \$305,733

Match Funding: \$14,332

Principal Project Manager: Dr. Scott Samuelson, (949) 824-5468

Commission Contract Manager: Dr. Avtar Bining, (916) 657-2002

Project Description: The purpose of this project is to support fuel cell development at the National Fuel Cell Research Center (NFCRC). NFCRC has been established at the University of California, Irvine (UCI) with the goal of both developing and transitioning to application, advanced power generation strategies that are both very energy efficient and environmentally sensitive. An integral component of the NFCRC is education and training, both directed to undergraduate and graduate students within the UCI, and the technical and business community outside the university. The infrastructure for the training center is partly funded through a Member Request Grant (MEM-97K-031, \$210,000, PVEA). PIER funds will be used for Analyses of Fuel Cell Systems and Cycle and Technology Transfer activities at the center.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by helping advance the development of clean and energy efficient distributed power generation technologies which will provide enhanced system reliability, highly efficient power generation, cleaner environment, and reduced cost.

Proposed Outcomes:

- Analyze Fuel Cell Systems and Cycles.
- Technology Transfer activities for distributed power generation technology at the National Fuel Cell Research Center Program.

Project Status: Analyses of Fuel Cell Systems and Cycles, and Technology Transfer activities for distributed power generation technologies at the center are continuing. Various elements will be completed by June 30, 2000. The project is within budget and is expected to achieve desired results.

Energy-Related Environmental Research Program Area

Project Title: REGIONAL AMBIENT AEROSOL STUDIES (RAAS)

Contract #: 500-97-010-04

Contractor and Major Subcontractors: PG&E and Atmospheric and Environment Research, Inc.; Douglas Becker; Kelly Managerial Service.

Contract Amount: \$399,000

Contractor Project Manager: Sam Altshuler, (925) 866-5879

Commission Contract Manager: Guido Franco, (916) 654-3940

Project Description: This project allowed PG&E to continue providing technical expertise to the California Regional PM10/PM2.5 Air Quality Study (particulate matter less than 10 and 2.5 micrometer (μm) size, respectively), a multi-agency study headed by the California Air Resources Board (CARB). Particulate matter (PM) smaller than approximately 2.5 micrometer (μm) tends to result from combustion processes including electric generating technologies, while PM larger than 2.5 μm results from sources such as wind-blown dust or seasalt. Significantly, it is PM2.5 that health experts consider most harmful to humans, because particles of this size can penetrate the body's natural defense mechanisms and reach most deeply into the lungs. For example, a recent comprehensive study has found that an increase of one microgram per cubic meter in particulates results in about four to eight more deaths per 100,000 live births (infant mortality).

The San Joaquin Valley is not compliant with the State ambient PM air quality standard of 50-micrograms/cubic meter. Central California (including San Francisco and Sacramento) is not compliant with the federal ambient PM air quality standard of 150-micrograms/cubic meter. Therefore, compliance with the particulate matter standard, the ultimate objective of the large research program headed by CARB, will result in significant health benefits in California.

This project supports the PIER Program objective of:

- Improving environmental and public health costs/risk of California's electricity by improving the scientific understanding of the PM problem in Northern California. It emphasizes the quantification of emissions, the chemistry and physics involved in the transport of PM, the formation and removal of PM and characterization of the meteorological conditions conducive to high concentrations.

Proposed Outcomes:

- Allow PG&E to continue providing technical expertise to the California Regional PM10/PM2.5 Air Quality Study.
- PG&E involvement in technical and policy discussions.
- Revise and provide comments on technical documents prepared for the study.
- Participate in research activities culminating in technical papers presented at conferences; publication of technical papers.
- Document a field research program conducted in 1995.
- Prepare conceptual models for ozone and particulate matter formation in the central California region.
- Prepare specific analyses such as the role of volatile organic compounds (VOC) in the formation of secondary ammonium nitrate in the San Joaquin Valley.

Actual Outcomes:

- Participated in the design and planning of the Central California Ozone Study (CCOS) as it evolved.
- Identified the possibility of long-range aloft transport and the need for a mesoscale (regional) domain model that includes upwind metropolitan areas such as the San Francisco Bay Area, Monterey, and San Luis Obispo.
- Team member Dr. Paul Solomon co-authored and published a paper, *Modeling the Effects of Emission changes on PM2.5 Using the UAM-AERO Model in the South Coast Air Basin*, in the Proceedings of the PM2.5 Conference in January 1998.
- Two articles written as part of the 1995 Integrated Monitoring Study have been published in a special issue of Atmospheric Environment, a premier air pollution peer-reviewed publication.
- The article *Ozone Formation in the California San Joaquin Valley: A Critical Assessment of Modeling and Data Needs*, authored by Pun et al, has been submitted and accepted for publication in the Journal of the Air and Wastes Management Association.
- Developed a conceptual model for fall and winter PM concentrations in the San Joaquin Valley using the data gathered during the 1995 Integrated Monitoring Study. This model provides a better balance between meteorological and chemistry in the analyses of PM episodes than previously developed models, allowing for increased accuracy in modeling PM concentrations.

- Developed a conceptual model, incorporating the physical dynamics and chemistry of O₃ formation in the San Joaquin Valley.
- Developed and used a box model to investigate the response of PM nitrate to reductions in precursor emissions within the San Joaquin Valley.
- Found that the formation of nitric acid and particulate nitrate is sensitive to oxidants and to volatile organic compound emissions during the fall and winter.

This project is expected to continue through 2003. The overall study headed by the CARB, has produced a number of conclusions to date including:

- The merits of detailed and complex analyses at fewer selected sites relative to less detailed measurements at more sites;
- The role of fog in PM formation and removal;
- The influence and regional extent of ammonium nitrate on wintertime PM formation;
- The degree that PM studies in one or two urban areas can be translated to other urban areas in the Central California region; and
- The degree to which residential wood burning is an important contributor to ambient PM.

PROJECT TITLE: BIRD STRIKE MONITOR

Contract #: 500-97-010-05

Contractor: Pacific Gas and Electric (PG&E)

Contract Amount: \$100,000

Contractor Project Manager: Sheila Byrne, (510) 866-5987

Commission Contract Manager: Linda Speigel, (916) 654-4703

Project Description: The purpose of this project was to develop an efficient and cost-effective system to detect electric power-disrupting bird collisions with powerlines using a wire-trip mechanism. This system is designed to provide power line owners with the tools necessary to identify the power lines responsible for multiple bird collisions, without spending excessive time or money for unreliable or labor intensive reconnaissance. Once the power lines with high number of bird strikes are identified, powerline owners can then initiate mitigation strategies to reduce collisions. The Bird Strike Monitor can be used by all utilities and applicable regulatory agencies to identify and mitigate power lines responsible for multiple bird collisions.

In locations that receive high use by migratory waterfowl, collisions with power lines can result in high bird mortalities, which is in violation of the Migratory Bird Treaty Act. There are numerous documented cases where listed species, such as the bald eagle and sandhill crane, have been killed as a result of collisions with power lines. Although collisions are frequent, they are often difficult to detect or are in remote locations. Current methods used to identify lines responsible for killing birds and to determine actual numbers of bird mortalities are labor intensive and unreliable. It is cost prohibitive to monitor the several thousand miles of power lines in the State and often birds that have been electrocuted are quickly removed by other wildlife before they can be detected. Furthermore, these bird collisions can cause expensive power outages or damage equipment. With the development of the Bird Strike Monitor, it may be possible to both decrease the number of bird-kills and power outages.

This project supports the PIER Program objectives of:

- Improving environmental and public health costs/risk of California's electricity by providing information to reduce bird mortality associated with powerline collisions; and
- Improving the reliability/quality of California's electricity by reducing bird-related power outages.

Proposed Outcomes:

- Develop an affordable, reliable and proven device to detect bird collisions with electrical transmission and distribution wires.
- Help identify locations along transmission and distribution lines with high incidence of bird collisions.
- Modify transmission and distribution lined to reduce collision risk.
- Help utilities comply with applicable laws such as the Migratory Bird Treaty Act, state and federal Endangered Species Acts, and the Bald Eagle Protection Act.
- Reduce the incidence of temporary power outages.
- Design specifications of the Bird Strike Monitor will be documented sufficiently for manufacture, once the prototype has been deemed cost effective and reliable.

Actual Outcomes: Results of tests on the Bird Strike Monitor and design specifications are due March 15, 2000. Copies of the final report will be available to interested parties. A final meeting will be scheduled to discuss the next steps that should be taken concerning the continued advancement of the Bird Strike Monitor.

Project Title: AVIAN POWERLINE INTERACTION COMMITTEE

Contract #: 500-97-010-06

Contractor: Pacific Gas and Electric (PG&E).

Contract Amount: \$40,000

Contractor Project Manager: Sheila Byrne, (510) 886-5987

Commission Contract Manager: Dick Anderson, (916) 654-4166

Project Description: This project developed a course on reducing bird electrocutions and electric power disruptions associated with bird collisions with powerlines as part of PG&E's involvement in the Avian Powerline Interaction Committee (APLIC). The APLIC is an internationally recognized organization with approximately a dozen utilities, as well as the U.S. Fish and Wildlife Service and the Audubon Society as members. It is dedicated to developing methods to mitigate the impact of powerlines on birds. Bird collisions with powerlines result not only in transmission line outages, but also harms or kills rare and endangered species.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by providing interested parties with current technical information on how to reduce bird collisions with powerlines, thereby lessening or preventing power outages resulting from these collisions; and
- Improving environmental and public health costs/risk of California's electricity by providing information to reduce bird mortality associated with powerline collisions.

Proposed Outcomes:

- Develop a course on reducing bird electrocutions and electric power-disruptions associated with bird collisions with powerlines as part of PG&E's involvement in the Avian Powerline Interaction Committee (APLIC).

Actual Outcomes:

The short course, entitled, "Reducing Bird Collisions and Electrocutions," was held in May of 1998 at PG&E's Livermore Training Center. The short course provided an excellent forum for information exchange regarding causes and solutions for many types of bird electrocution and collision fatalities and associated power outages. Measures presented to reduce bird electrocutions included special insulation for potential electrocuting contact points and using an electrocution-proof configuration design in the construction of new powerlines. Measures discussed to reduce collisions included avoiding high bird use areas in siting of new powerlines and attaching various shaped devices (bird flight

diverters) in order to alert birds to the hazard and allow them to avoid the line. Information was distributed to course attendees that will allow them to evaluate existing structures and recommend measures, as needed, to decrease adverse bird interactions with utility structures. The short course was well attended and received high marks by attendees.

Project Title: FOOD SERVICE TECHNOLOGY CENTER

Contract #: 500-97-010-07

Contractor and Major Subcontractors: Pacific Gas and Electric (PG&E) and Fisher-Nickel Inc.; Fisher Consulting; Food Service Technology Center.

Contract Amount: \$350,000

Contractor Project Manager: Grant Brohard, (925) 866-5713

Commission Contract Manager: Dr. Obed Odoemelam, (916) 654-4171

Project Description: This purpose of this two-part project was to establish a standard method for measuring emissions from commercial kitchens, and methods for reducing such emissions within the industry. The second part is aimed at establishing industry-wide design guidelines for achieving and maintaining optimum performance and energy efficiency in commercial kitchen ventilation systems.

This project supports the PIER Program objective of:

- Improving the energy cost/value of California's electricity by identifying ways to optimize the energy used for ventilation in commercial kitchens and reducing the health risks associated with emissions from these kitchens.

Proposed Outcomes:

- Maximize energy efficiency in commercial kitchen ventilation systems (CKV) in a way that will maintain the health and safety functions of the CKV system.
- Develop uniform test methods for characterizing emissions with regard to composition and major sources.
- Develop effective emission control approaches.
- Provide information for kitchen designers, mechanical engineers, food service operators, property managers, and maintenance people about achieving and maintaining optimum performance and energy efficiency in CKV systems.
- Provide information applicable to new construction and, in many instances, retrofit construction;
- Disseminate research through workshops and publications

for the benefit of the industry and regulatory agencies concerned about these emissions.

- Develop industry-wide guidelines for designing, installing and operating ventilation systems in terms of health and safety, effectiveness and energy efficiency.

Actual outcomes:

Testing portion of the project (instrument calorimeters for particulate matter and for heat gain measurement) was completed. These tests were conducted to establish a site for future testing purposes.

- Two new approaches to minimize emissions were developed, tested and evaluated. The first approach uses grease extractors to minimize emissions during the cooking process. The second approach uses catalysts in hoods for the removal of Particulate Matter resulting from the cooking process. Both of these emission control approaches were determined to be successful and have the potential for future use in the food service industry.
- A workshop on emissions measurement and control was held for the food service industry in San Francisco. The purpose of the workshop was to establish emission factors used for measuring emissions from commercial kitchen ventilation systems (CKV) systems. Designers and manufacturers from all over the country participated in this conference. Workshop proceedings were provided to interested parties;
- A Commercial Kitchen Ventilation System Performance Evaluation and Optimization workshop was held to demonstrate the methods developed to evaluate the efficiency of CKV systems. A report on the evaluation methods was prepared and made available to interested parties.
- A computer model designed to conduct cost assessments for commercial kitchen ventilation systems was developed and made available for industry-wide use. This model is designed to consider specific conditions and needs for individual commercial kitchens and allow for cost-effective CKV system designs.
- A draft of industry-wide guidelines for designing, installing and operating ventilation systems in terms of health and safety, effectiveness, and energy efficiency has been completed, but because of unexpected circumstances, a no-cost time extension to complete the final guidelines was requested and granted.
- Final report is expected January 31, 2000, and will be available to interested parties from the contract managers.

Project Title: WILDLIFE INTERACTIONS WITH UTILITY FACILITIES

Contract: 500-97-010-08

Contractor and Major Subcontractors: Pacific Gas and Electric with Colson and Associates.

Contract Amount: \$130,000

Contractor Project Manager: Mark Dedon,
(510) 866-5829

Commission Contract Manager: Rick York,
(916) 654-3945

Project Description: The purpose of this project was to analyze products that reduce or prevent wildlife interactions, and resulting electrocutions and power outages, with powerlines and power facilities. Distribution line add-on insulation and perch deterrent products that were added to distribution line power poles were analyzed to evaluate their durability and effectiveness.

This research project also evaluated the applicability and effectiveness of a geographic information system (GIS) model that would allow Pacific Gas and Electric (PG&E) to plan future electrical facility upgrades to reduce wildlife electrocutions and associated power outages. The GIS model is designed so it can also help predict "high risk" areas so new distribution lines and existing distribution line upgrades are designed so wildlife electrocution-related power outages are minimized. The GIS model was also developed in response to a 1994 settlement agreement between PG&E and the U. S. Fish and Wildlife service that arose after citations were issued to PG&E for the electrocutions of several Swainson's hawks, a State-protected species. Birds and other animals are the fourth leading cause of electric distribution outages in the PG&E system.

This project supports the PIER Program objectives of:

- Improving environmental and public health costs/risk of California's electricity by improving current systems and technologies that prevent bird electrocutions caused by powerlines; and
- Improving the reliability/quality of California's electricity by reducing bird-related power outages.

Proposed Outcomes:

- Conduct research to evaluate the durability of specialized add-on insulation products and perch deterrent products installed in the field to reduce wildlife electrocutions and resulting outages. Based on preliminary laboratory tests conducted by PG&E during 1996-97, some insulation

products are susceptible to degradation caused by various environmental factors such as moisture, sunlight, contaminants, etc. Some materials deteriorated quickly in laboratory tests and PG&E has recovered some products that have deteriorated in the field. This research was to examine the condition of various products installed in the field and installation procedures as appropriate.

- Address the usefulness of the GIS model that incorporates the PG&E electrical distribution network and predictable wildlife resources to reduce the risk for wildlife electrocutions/collisions and outages on selected circuits. The GIS model was developed by PG&E in 1997 to aid in predicting areas susceptible to wildlife interactions. Electric planners and engineers believe a GIS system could improve system reliability when used for planning new circuits or upgrading existing circuits.
- Evaluate the GIS system in selected PG&E divisions to obtain data on its usefulness. The merits of this system will be shared with other utilities to determine its applicability outside the PG&E service area.

Actual Outcomes:

Wildlife-Protective Devices

Objective:

- To better understand the expected life span of wildlife-protective devices in the field

Outcomes:

- Based on the limited sample of protective devices observed, approximately 15 percent showed a degree of degradation that is likely to reduce their performance.
- Approximately 65 percent of the poles observed had wildlife protective devices that were not installed according to manufacturer recommendations or PG&E Engineering Standards. Installations were incomplete or improperly executed.
- While PG&E cannot say that improper or incomplete installation practices or degrading devices are the reason wildlife-caused outages continue to trend up in most PG&E divisions, it is likely they result in providing a risk for future outages.

Geographical Information System (GIS)

Objective:

- To implement the GIS developed in the pilot study throughout PG&E's service territory.

Outcome:

- The GIS system is now being used for a selected PG&E service territory.

Objective:

- Encourage use of the GIS by planners to better design new circuits in areas vulnerable to wildlife-caused outages.

Outcomes:

- The project benefits from the use of PG&E's Intranet Map Server with centralized data. PG&E distribution planners are gradually discovering its usefulness in the design of new circuits and upgrades to existing circuits.
- Currently, GIS training is in high demand and user feedback is extremely positive.

Objective:

- Develop a risk model that indicates "high risk" areas where birds are more vulnerable to electrocution within PG&E's service area.

Outcome:

- The GIS provides the required risk model to comply with the PG&E/U.S. Fish and Wildlife Service settlement agreement.

Objective:

- Demonstrate that a GIS can be created to plan and build a reliable electrical system that is less likely to have wildlife-related power outages.

Outcome:

The PG&E project manager is available to demonstrate the GIS capabilities, discuss how the GIS was created and other sources of GIS/map information, and advise others how to design a similar system.

Project Title: TRENCHLESS BURIAL EQUIPMENT

Contract: 500-97-011-01

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$130,000

Contractor Project Manager: Tamme Candelaio,
(415) 973-8873

Commission Contract Manager: Ellen Townsend-Smith,
(916) 654-4170

Project Description: The purpose of this project was to develop three time- and cost-saving technologies that will allow utilities to construct and maintain underground electrical distribution facilities. Remote sensing and detection equipment would be developed that improves the utilities' ability to service existing underground facilities and improves the current underground tunnel boring technologies.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by developing technologies that will allow utilities to reduce power outages and minimize the impact of such outages when they occur.

Proposed Outcomes:

- Develop a wireless fault indicator which would allow SDG&E crews to locate cable faults with a hand-held radio device rather than the conventional method of physically opening vaults to inspect fault switches;
- Develop and demonstrate SafeNav, a device for detecting and avoiding underground obstacles before collision during boring; and
- Develop a digital imaging system designed to improve the productivity and safety during inspection and inventory of underground distribution facilities.

Actual Outcomes:

- The Radio Based Fault Indicator (RBFi), a wireless radio-based fault indicator technology would allow crews to locate underground cable faults with a hand-held radio device, instead of the conventional manual way by physically opening vaults to inspect fault switches. A RBFi unit is installed within a manhole or underground vault. During a power outage, utility personnel drive to the vicinity of the suspected fault, and poll (query) the Fault Indicator unit with a hand held reader that displays the indicates the condition of the fault. In early field-testing, 40 units were installed and tested by field crews at SDG&E. Several of the units failed because of moisture (or other contamination) intrusion in the battery case. Although field-testing demonstrated that the concept is technically valid, financial constraints prevent the contractor from pursuing design modifications. These issues are not deemed insurmountable and further funding is under consideration because of anticipated benefits in the areas of labor reduction, timesaving and improved system reliability, and personnel safety by avoiding having to physically open vaults.
- SafeNav, an underground horizontal drilling technology, detects underground obstacles and notifies the driller by alarms when obstructions are located within the bore path. SafeNav is designed to minimize damage to existing underground utilities and lower the occurrence of outages and associated safety hazards. Under this project, preliminary field-testing was completed and necessary design modifications developed. The results of these tests suggest that SavNav could improve safety, reduced drilling costs, result in faster installation time, and less disruption

to consumers. If successfully commercialized, anticipated savings from the system are estimated to exceed \$300,000 annually, when comparing actual horizontal drilling to open trenching costs in a typical fiscal year.

A Digital Inspection System (DIS) would allow access to underground facilities through an existing orifice on a manhole or handhole cover. A probe is placed into the vault to image the surrounding walls thus, mapping the vault configuration. The Digital Imaging Systems enables one person to perform the inspection, resulting in substantial savings in labor costs and reduced exposure to hazardous conditions. In conventional methods, entry to subsurface structures for inspection requires elaborate procedures to render the spaces safe. This includes water-pumping and atmosphere purging, involving crews of at least three people. Under this project, a design analysis was completed to define parameters for hardware selection. Bench scale testing identified a number of engineering issues including maintaining spatial orientation and visual resolution. These issues will be addressed in the next phase of the project.

Project Title: WATER AND WASTEWATER ELECTROTECHNOLOGIES

Contract #: 500-97-012-01

Contractor and Major Subcontractors: Edison Technology Solutions (ETS) and Metropolitan Water District; Orange County Water District; Electric Power Research Institute (EPRI).

Contract Amount: \$410,000

Contractor Project Manager: Lory Larsen, (626) 633-7161

Commission Contract Manager: Wendell Bakken, (916) 654-4042

Project Description: The purpose of this project was to develop electrotechnologies which can produce new supplies of reliable and affordable drinking water, reduce electrical use to deliver and treat that water, and reduce the environmental problems created by current treatment and transport processes.

This project supports the PIER Program objective of:

- Improving environmental and public health costs/risk of California's electricity by possibly eliminating some conventional, chemically-intensive water treatment techniques and by helping to avoid transfers of water from environmentally sensitive areas in Northern California to Southern California.

Proposed Outcomes:

- Demonstrate Colorado River Water (CRW) salinity reduction measures using reverse osmosis (RO) and capacitive deionization (CDI) with carbon aerogel.
- Demonstrate the use of pulsed UV for disinfection and membrane biofouling control.
- Investigate the formation and control of bromate during ozonation.
- Study the disinfection of reclaimed wastewater with UV.
- Evaluate the performance of low-pressure membranes.
- Demonstrate that high-energy injection (E-Beam) is an effective alternative for water treatment.

Actual Outcomes:

- Both conventional treatment with and without ozone and biofiltration produced an effluent water quality suitable for use with RO. Significant energy savings can be realized with the use of ultra-low-pressure RO membranes over the previous generation of low-pressure RO membranes; however, large diameter RO elements are required for membrane technology to be implemented on a large scale. Carbon aerogel CDI technology has great potential, but the technology requires more development. Future CDI evaluations should be conducted at bench scale.
- Pulsed UV disinfected up to 99.99 percent of targeted virus and bacterial and would be significantly less costly than ozone or membrane Cryptosporidium reduction technologies. This technology could be an additional barrier to pathogenic organisms in drinking water treatment.
- Lowering pH before ozonation was effective in reducing bromate formation, but the technology is expensive compared to chlorination because of the large chemical dosages of acid required for pH control. Ammonia is a promising bromate control strategy for the Colorado River water at ozone doses required for enhanced Cryptosporidium disinfection. Hydrogen peroxide is not an effective bromate control strategy at the ozone doses required for 90 percent inactivation of Cryptosporidium.
- Ultraviolet disinfection is a viable alternative to adding chlorine to wastewater in the presence of ammonia for disinfection of reclaimed wastewater for non-potable reuse, and UV is much more effective in destroying bacteria. A 99.99 percent inactivation of indigenous coliphage and a 99.99 percent virus inactivation at the pilot plant was achieved.

- Ease of reclaiming water decreased as the quality of the feedwater decreased. Generally, microporous membrane permeability decreased as the concentration of suspended solids and biochemical oxygen demand in the feed water increased. Biological Oxygen Demand (BOD) can be used as a measure of the extent to which the water is polluted with organic compounds.
- High energy electron beam injection is an effective alternate water treatment method by meeting or approaching Maximum Containment Levels (MCLs) on a variety of priority contaminants. Additionally, costs to install and operate the system are competitive and potentially much lower than conventional and other emerging alternates and treatment on MDMA, an organic carcinogenic contaminant, showed effective removal rates at costs lower than existing chemical destruction technologies.

Project Title: HABITAT AND SPECIES PROTECTION

Contract #: 500-97-012-05

Contractor and Major Subcontractors: Edison Technology Solutions (ETS) and Electric Power Research Institute (EPRI); Ed Almanza and Associates; University of California, Irvine; Premier Temporary Service; Bio Resources Consulting; Positive Systems; Applied Biomathematics.

Contract Amount: \$525,000

Contractor Project Manager: Dan Pearson, (626) 302-9562

Commission Contract Manager: Marc Sazaki, (916) 654-5061

Project Description: The goal of this project was to minimize raptor mortality (and resulting electric power disruptions) associated with power lines by identifying where and why this mortality occurs and then developing recommendations to minimize these impacts. Research was also conducted to determine methods for minimizing the impacts of power facility construction on sensitive species and habitats.

This project addresses the PIER program objectives of:

- Improving environmental and public health costs/risk of California's electricity by developing methods to minimize the environmental impact of power facilities on sensitive species and habitats; and
- Improving the reliability/quality of California's electricity by reducing bird-related power outages.

Proposed Outcomes:

- Reduce raptor mortalities caused by electrocution at power lines and power outages associated with such instances system-wide. Consequently, raptors would be protected and power line system reliability would be improved.
- Develop protocols to characterize and monitor critical California habitat types to avoid or minimize impacts through multiple species habitat conservation research and habitat evaluation. Given the development of these protocols, fewer habitat and species issues should arise.

Actual Outcomes:

- Produced a series of reports that present reliable and cost-effective methods for identifying areas with recurring raptor electrocution problems. Appropriate mitigation actions can be applied in problem areas where found.
- A series of reports have been completed that describe advanced aerial mapping techniques that can be used for characterization of plant species composition and abundance in sensitive habitats that may be used by a multitude of wildlife species, such as the legally protected California gnatcatcher. In addition, models that estimate extinction rates for threatened and endangered species are described, including the California gnatcatcher and the desert tortoise. These methods are available for use to minimize potential impacts associated with electricity development in California.

The reports will soon be made available on the Commission's Web site; for now they are available from the Project Contract Managers.

Project Title: DESERT AND MOUNTAIN AIR TRANSPORT

Contract: 500-97-012-06

Contractor and Major Subcontractors: Edison Technology Solutions with Electric Power Research Institute (EPRI); and South Coast Air Quality Management District (SCAQMD).

Contract Amount: \$825,000

Contractor Project Manager: Vincent Mirabella, (626) 302-9748

Commission Contract Manager: Tuan Ngo, (916) 654-3852

Project Description: The purpose of this project was to develop and apply new methods for characterizing and quantifying the regional transport and chemistry of visibility-

impairing emissions (haze) leading to improvements in regional visibility in California. (Haze refers to atmospheric moisture, dust, smoke and vapor suspended to form a partially opaque visual condition). The modeling tools and methods developed under the DMAT Project will provide focus on the special visibility problems facing several Class I areas located in California as well as assist in developing assessment technologies for addressing the visibility problems facing urban areas of California.

This project supports the PIER program objective of:

- Improving environmental and public health costs/risk of California electricity by providing the knowledge of the transport and chemistry of visibility-impaired emissions to address the protection of visibility at mandatory federal Class-I areas in California and elsewhere.

Proposed Outcomes:

- Interpret inert tracer data released as part of the project to characterize the transport of emissions from various regions of the western United States;
- Assess the reliability of currently available regional transport and chemistry visibility models; and
- Develop "conceptual models" to provide a fundamental understanding of the transport and chemical mechanisms that cause western visibility impairment.

Actual Outcomes:

- The DMAT study concluded that there is no direct relationship linking the emissions from a particular source to the regional visibility impairment in the Grand Canyon National Park.
- The study concluded that the visibility impairment problem was caused by a combination of many industrial sources including those in Southern California, Northern Mexico and Las Vegas.
- The analysis of inert tracer data is inconclusive and did not establish the reliability of current regional transport and chemistry visibility models. This is likely due to different mechanisms of sulfate formation chemistry in the clouds assumed in each model.
- CALMET was determined to be the most successful model among the models used to generate the wind fields that affect the transport of air pollutants.
- A conceptual model was developed and evaluated for simulating the formation of aerosols and photochemical ozone from a point source. Further testing is needed prior to the model being used on an operational basis.

Project Title: FORMATION OF NOX IN INDUSTRIAL GAS BURNERS

Contract #: 500-97-013-09

Contractor and Major Subcontractors: California Institute for Energy Efficiency (CIEE) and University of California, Irvine; Combustion Lab; Scott Samuelson.

Contract Amount: \$335,000

Contractor Project Manager: Jim Cole, (510) 486-4123

Commission Contract Manager: Matt Layton, (916) 654-3868

Project Description: The purpose of this project was to develop technologies (and associated scientific and applications-oriented knowledge) to attain and maintain energy-efficient operation of natural gas industrial burners and stationary gas turbines with ultra-low emissions of nitrogen oxides (Nox). The core component of this project will be a closed-loop combustion control with advanced sensors, including field applications applied to industrial burners and boilers. The high temperature and boiler elements of this project, funded by Southern California Gas, Maxon and Coen, involve laboratory field testing and other technology transfer activities that interact synergistically with the core component.

Low emissions technologies are driving the development of new generation stationary power sources. The next generation industrial burners and stationary gas turbine combustors will be required to maintain extremely low levels of nitrogen oxides (NOx) and carbon monoxide (CO) emissions, previously thought unattainable. Current state-of-the-art is to use back-end clean up of the exhaust stream with selective catalytic reduction (SCR) or a similar technique. This method, although effective, is costly. Alternatively, burner and gas turbine combustor manufacturers are striving to reduce the pollutants at the source by adopting a lean-premixed or partially-premixed fuel and air strategy; the challenge with lean premixed systems is that CO can increase and stability can decrease along with the reduction in NOx.

This project supports the PIER Program objective of:

- Improving environmental and public health costs/risk of California's electricity by maintaining the energy efficiency and ultra-low emissions achieved in natural gas industrial burners and stationary gas turbines.

Proposed Outcomes:

- Further develop the active control system on a boiler burner (the first demonstration occurred through the CIEE core program).

- Proof-of-concept of the active control on a gas turbine, both applications targeting the energy/electrical production market. The core component is a closed loop combustion control with advanced sensors, including demonstrations applied to industrial burners and gas turbines.
- Identify fast feedback sensors.
- Determine the suitability of these fast sensors for industrial burners and gas turbine applications.
- Upgrade the active control software for ease-of-use and fast feedback capability.
- Refine the use of the fast sensors and new software on industrial burners.
- Demonstrate the fast sensors and new software on a gas turbine combustor.
- Transition the experimental results to the combustion community.

Actual Outcomes:

A comprehensive active control strategy was successfully demonstrated for industrial gas burners and stationary gas turbines during this one-year project.

- The fast sensors that were investigated and selected for trials were fiber optic collection of reaction chemiluminescence, an acoustic microphone, and a piezoelectric, dynamic-pressure sensor.
- The active control computer system consisted of commercial software and hardware (National Instruments LabView and data acquisition boards) in conjunction with simple optimization techniques.
- Control of the combustion processes was achieved using mass flow controllers to optimize the fuel injection and airflow at different operating conditions.
- A second-generation active control system using fast sensors was demonstrated on two different sized industrial burner systems and a gas turbine combustor.
- Transition of the results to the combustion community occurred via three presentations of the project results at two different combustion conferences and through personal interaction with industrial burner and gas turbine manufactures at the conferences.

The successes of this research are encouraging and timely for the electric industry in California. Central station and small, distributed generators will compete in the deregulated electricity market, which could mean constant cycling of firing rate while still complying with some of the strictest air pollution regulations in the country.

Project Title: GOLDEN EAGLES IN A PERILOUS LANDSCAPE: TRACKING THE EFFECTS OF MITIGATION FOR ENERGY BASED MORTALITY

Contract #: 500-97-036

Contractor and Major Subcontractors: University of California at Santa Cruz and H. Peters Consulting.

Contract Amount: \$675,121

Contractor Project Manager: Grainger Hunt, (530) 336-7281

Commission Contract Manager: Dick Anderson, (916) 654-4166

Project Description: This purpose of this project is to assist in understanding the complex interactions of golden eagles with the electrical power producing Altamont Pass Wind Resource Area (WRA) structures. In the Altamont WRA, an estimated 40-60 golden eagles and several hundred red-tailed hawks are killed annually by collisions with wind turbines. Electrocution is another source of golden eagle fatality, both within and outside the WRA. These fatalities are a concern for stakeholders and produce costly permitting delays.

This project supports the PIER Program objectives of:

- Improving the environmental costs/risk of California's electricity by providing critical information to help reduce golden eagle fatalities in the Altamont Pass WRA; and
- Improving the reliability/quality of California's electricity by providing information to overcome regulatory barriers to siting or replacing wind turbines.

Proposed Outcomes:

- Provide information focusing on whether the WRA-wide golden eagle population is stable, increasing in size or declining in size.
- Determine whether there is a correlation between golden eagle use of the WRA and ground squirrel concentrations.
- Determine whether ground squirrel concentrations are attracting golden eagles into risky situations.
- Document golden eagle use of the following areas:
 - 1) Where recent structural modifications have been made.
 - 2) Where wind turbines in high risk areas have been removed (determined by incidental carcass discoveries).
 - 3) Where there has been repowering of some areas with new, larger, more efficient wind turbines.

- Improve public perception of wind power because the net result of the industry's efforts to mitigate this issue can be directly measured.

Project Status: The project is on schedule and within budget and expected to meet all objectives. The term of the project is to March 31, 2002.

Project Title: GLOBAL CLIMATE CHANGE - CALIFORNIA IMPLICATIONS AND POTENTIAL COSTS

Contract Number: 500-97-043

Contractor and Major Subcontractors: Electric Power Research Institute (EPRI) and Charles Rivers Associates, Stratus Consulting, Exponent Health Group, and several professors from Yale, Stanford, U.C. Davis, MIT, University of Colorado, and Oregon State University.

Contract Amount: \$2,159,800

Match Funding: \$28,400,000

EPRI Project Manager: Richard Richels, (650) 855-2602

Commission Contract Manager: Guido Franco, (916) 654-3940

Project Description: The purpose of this project is to study the phenomenon of climate change, and from the understanding gained, provide the information necessary to evaluate the best options for addressing the impacts of climate change in the U.S. including a focus on California. This project will improve our understanding of the potential physical impacts of global climate change in California and the impacts of efforts to reduce greenhouse gas emissions on the State's economy, the State's energy system, and electricity production in particular.

PIER funding allows a more in-depth analysis in California than what would be gained by national studies alone. Specifically, this project will improve our understanding of the potential climatic changes in California, including the potential general impacts on ecosystems, agriculture, hydroelectric resources and water resources, as well as energy consumption and other areas affected by climate. This project will also identify potential adaptation measures to address the expected climate impacts. EPRI will estimate the direct economic impacts, including energy prices impacts that would be incurred in the next 30 years due to the implementation of national or international programs designed to reduce greenhouse gas emissions, such as the Kyoto Protocol.

This project supports the PIER program objective of:

- Reducing environmental and public health costs/risk of California's electricity by conducting research to support California energy policy initiatives and further research related to global climate change.

Proposed Outcomes:

- Assess the potential costs and implications to California of global climate change. The assessment will make extensive use of the existing framework and expertise developed by EPRI and its subcontractors for similar studies conducted at the national and international levels;
- Reduce the uncertainty in, and improve the performance of, general circulation and carbon cycle models used to predict climate change effects;
- Study the potential effects of climate change on human health, economic activities, and natural ecosystems;
- Evaluate regional impacts of possible climate changes, including potential effects in California on agriculture, forestry, and water resources. The project will also examine the economic implications of proposed climate change mitigation policies as they could affect California, such as increasing prices for electricity and fuels; and
- Enhance an integrated assessment framework and use it to examine alternative proposals for reducing greenhouse gases in terms of costs and benefits.

Project Status: The project is on schedule and within budget. Due to the large scope of this project, the Commission Contract Manager has created an external review team formed by representatives from different State agencies, such as the Department of Fish and Game and the Department of Food and Agriculture. They are involved directly in the design of the different studies and will review the draft and final products. The aim of this effort is to make sure that the study results are directly applicable and relevant to agencies managing the state resources, including energy, that would be affected by global climate change.

The California specific products expected in the year 2000 include:

- 1) Detailed climatic scenarios;
- 2) Expected changes in vegetation patterns;
- 3) Evaluation of health effects due to El Niño events;
- 4) Preliminary economic evaluation of the potential impact of the Kyoto Protocol; and
- 5) Preliminary evaluation of impacts on agriculture and water resources.

Project Title: ELECTROTECHNOLOGY APPLICATIONS FOR POTABLE WATER PRODUCTION AND PROTECTION OF THE ENVIRONMENT

Contract #: 500-97-044

Contractor and Major Subcontractors: Southern California Edison (SCE) and Metropolitan Water District of Southern California; Orange County Water District; University of California, Riverside; Innovatech Corp.; Utility Technology Associates; Electric Power Research Institute (EPRI).

Contract Amount: \$2,889,678

Match Funding: \$13,936,267

Contractor Project Manager: Lory Larson, (626) 815-0520

Commission Contract Manager: Wendell Bakken, (916) 654-4042

Project Description: The purpose of this project is to develop electrotechnologies, which can produce new supplies of reliable and affordable drinking water, reduce electrical use to deliver and treat that water, and reduce the environmental problems created by current treatment and transport processes. Six innovative electrotechnology-based water treatment processes will be evaluated to 1) investigate advanced oxidation processes, 2) evaluate biological denitrification, 3) study solids removal technologies, 4) assess salinity removal technologies, 5) investigate disinfection alternatives, 6) demonstrate solids processing techniques, 7) perform energy and process assessment for system optimization, and 8) investigate scale-up issues and provide technology transfer.

This project supports the PIER Program objective of:

- Improving the environmental and public health costs/risks of California's electricity by avoiding electricity use and costs to transport water over long distances and by avoiding investments in long-distance water transfer projects.

Proposed Outcomes:

- Evaluate two advanced oxidation processes: pulsed UV/ hydrogen peroxide and ozone/hydrogen peroxide, for their effectiveness in removing methyl tertiary butyl ether (MTBE), perchlorate, and other synthetic compounds from surface water and groundwater supplies.
- Demonstrate how biological denitrification helps reduce concentrations of nitrate in contaminated wells to acceptable limits so that these wells can be re-activated as drinking water sources.
- Evaluate the performance of solids removal technologies for surface water, municipal wastewater, and agricultural

drainage water as a pretreatment for salinity removal processes.

- Evaluate the effectiveness of two, non-thermal desalination technologies for the demineralization of surface water, reclaimed water, and agricultural drainage water. The non-thermal desalination technologies to be evaluated are experimental membranes (reverse osmosis (RO) and nanofiltration (NF) membranes) and carbon aerogel capacitive deionization (CDI).
- Evaluate the effectiveness of pulsed-UV irradiation and ozone as physical, post-filtration disinfection processes for the inactivation of viruses, bacteria, and protozoa.
- Investigate the effectiveness of mechanical freeze-thaw conditioning to enhance the dewatering of waste-stream residuals (sludge) from both conventional and desalting water treatment processes.
- Conduct energy assessments of municipal water and wastewater unit processes to determine their energy use

and water quality processing characteristics and to identify areas for improvement through application of electrotechnologies.

- Evaluate preliminary scale-up issues for pulsed-UV irradiation, microfiltration for solids removal and desalting membranes. More specifically, a larger pulsed-UV treatment chamber, a demonstration MF system, and new, large diameter reverse osmosis membrane elements will be designed and tested for large-scale water and wastewater applications.
- Connect the results from the electrotechnology research conducted through this contract to the research and water utility industry which can apply the results to their own research and which can adopt the technologies into their water-utility operations.

Project Status: The project is on schedule and within budget.

Strategic Energy Research Program Area

Project Title: ELECTRIC SYSTEM SEISMIC SAFETY AND RELIABILITY

Contract: 500-97-010-09

Contractor and Major Subcontractors: Pacific Gas and Electric Company and University of California, Berkeley Pacific Earthquake Engineering Research Center (PEER).

Contract Amount: \$1,000,000

Contractor Project Manager: Dr. William (Woody) Savage, (415) 973-3116

Commission Contract Manager: Robert Anderson, (916) 654-3836

Project Description: The purpose of this project is to support several major research projects in the field of electric system seismic safety and reliability. Projects ranged from the shake table testing of electric bushings and the collection of soil data at existing substations, to the development of a rapid response, strong ground shaking contour map program and related strong ground motion attenuation curves. Some of the early products have already been incorporated by a major California utility in their risk management practices. This contract was extended through January 31, 2000, due to the interruption of research report preparation by investigators assigned to assess damage in Turkey after the August 17, 1999, magnitude 7.4 Kocaeli earthquake.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by reducing the vulnerability of the electric transmission and distribution system due to damage caused by a major earthquake, continuation of power in an area affected by an earthquake and/or by the rapid recovery of the electric service. This rapid recovery will allow for a shortened interruption to emergency services and businesses due to the loss of electric power.

Proposed Outcomes:

- Improvements to installed utility equipment will be identified and tested, and the potential for future disruptions due to earthquake-induced damage can be reduced.
- Develop improved assessments of shaking-caused permanent ground deformation hazards in formats that the utility can directly use for evaluating electric system vulnerabilities.
- Examine the process of fire initiation during power restoration following earthquakes to evaluate various means to reduce the risk of starting fires.
- Develop the capability to analyze data from distant seismographic instruments to accurately predict the

pattern and severity of strong earthquake shaking anywhere in the State.

Project status: The project is on schedule, within budget and is expected to achieve the proposed outcomes.

Project Title: DYNAMIC CIRCUIT THERMAL LINE RATING (DCTR)

Contract: 500-97-011-05

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$110,000

Contractor Project Manager: Bill Torre, (619) 696-4880

Commission Contract Manager: Linda Davis, (916) 654-3848

Project Description: The purpose of this project was to develop and demonstrate real-time transmission line ratings. DCTR uses equipment mounted on a transmission tower to monitor the line conductor tension and determine ground clearances and weather conditions to calculate the amount of current that can be transmitted in real time. This information is provided to system operators or engineers for their use in safe, reliable and economic system operation. Conventional transmission lines ratings have been established as static rating, which may be lower than the maximum capability of the conductor. By monitoring wind speed, conductor tension and solar heating, a real time line rating may be calculated that is closer to the maximum conductor capability.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity since using real time dynamic line ratings ensures reliability and quality by making sure that ground clearances are not exceeded thus avoiding contact and flashovers which cause power outages and voltage surges;
- Improving the energy cost/value of California's electricity by improving transmission line utilization to facilitate economic transactions and reduce costs as real time ratings allow greater power transfers on existing facilities than the static line rating;
- Improving the environmental and public health costs/risks of California's electricity by improving utilization of existing transmission lines thereby avoiding the need for new lines and the associated environmental impacts; and
- Improving the safety of California's electricity by using real time information to make certain that ground clearance limits are not exceeded thus avoiding the risk of electrical shock and fires.

Proposed Outcomes:

- Increase transmission capacity on congested transmission lines to allow increased power transfers.
- Reduce use of expensive generators which "must run" due to transmission rating constraints.
- Promote the use of more economic generators to result in reduced energy system price for utility customers.

Actual Outcomes:

- The dynamic real time rating for the demonstration was up to 150 percent more than the normal rating at some times. From 9 a.m. through 5 p.m., the dynamic rating averaged a 75 percent increase in rating over the normal rating on that circuit.
- The real time rating also indicates that line ratings are sometimes reduced, and eliminates the risk of sagging the conductor to the point of contact thus preventing danger to the public.

Project Title: SYSTEM STABILITY AND RELIABILITY: FLEXIBLE AC TRANSMISSION SYSTEMS (FACTS) BENEFITS STUDY

Contract #: 500-97-011-06

Contractor: San Diego Gas and Electric (SDG&E)

Contract Amount: \$100,000

Contractor Project Manager: Abbas Abed, (619) 696-2755

Commission Contract Manager: Linda Davis, (916) 654-3848

Project Description: This project investigated the feasibility and benefits of implementing Flexible AC Transmission System (FACTS) devices on Extra High Voltage (EHV) electricity transmission lines to increase power transfer capability and electricity import capability. The use of Static Condensers (STATCON), Thyristor Controlled Series Capacitors (TCSC) and Static Var Controllers (SVC) were examined in this previous study.

To meet the forecasted future electrical load in California, either additional generation must be installed or import capability must be increased. FACTS technologies help improve power transfer, power quality and system control. FACTS technologies use high-speed, thyristor-controlled devices and advanced control concepts to allow loading lines to their thermal limits without compromising system reliability. This study conducted detailed technical and economic studies to investigate the benefits of FACTS technologies for the SDG&E service territory.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by allowing operators to load lines to their thermal limits without compromising system reliability;
- Improving the energy cost/value of California's electricity by improving the efficiency of the power transfer capacity of the electricity transmission system; and
- Improving the environmental and public health costs/risks of California's electricity by improving the power carrying capability of the existing system thereby reducing the need for new transmission lines.

Proposed Outcomes:

- Conduct detailed technical and economical studies to investigate the benefits of Flexible AC Transmission Systems (FACTS) devices located in SDG&E's service territory. The study focus was on the potential benefits of existing and new FACTS devices in improving SDG&E's import capability.

Actual Outcomes:

- Preliminary studies show that facility overload and reactive power deficiency are the main problems associated with increasing SDG&E's import capability.
- FACTS technology can be used to mitigate both problems and could possibly increase SDG&E's simultaneous import capability by 300 MW by relieving line overloads and providing dynamic reactive power support.
- FACTS also could possibly increase non-simultaneous import capability by 250 MW by relieving line overloads and providing dynamic reactive power support.
- The system transfer capability increases can also be achieved through rearrangement of transmission circuits at lower cost than the FACTS technology.

Project Title: PHASOR MEASUREMENT UNITS

Contract #: 500-97-012-12

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$150,000

Contractor Project Manager: Mohan Kondragunta, (626) 815-0507

Commission Contract Manager: Linda Davis, (916) 654-3848

Project Description: This project demonstrated real-time monitoring and potential of future control of the Western Systems Coordinating Council (WSCC) electric power grid

using Phasor Measurement Units (PMUs), which are low-cost sensors that measure voltage, current phase angles and magnitudes that are time tagged for relative comparison between geographically distant locations in Southern California and Oregon.

The PMUs communicate real-time data to a Phasor Data Concentrator (PDC) at very high speed using communication systems from all the monitoring sites. The system will allow various energy control centers and systems to monitor the entire WSCC system and will help to provide information to prevent wide scale power outages. The project will develop a system to pool data from all major WSCC members and make it available to all participating members for post-disturbance analysis.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by allowing regional energy control centers and systems to monitor the entire WSCC system; and
- Improving the energy cost/value of California's electricity by reducing wide scale power outages.

Proposed Outcomes:

- Develop a system that facilitates real-time monitoring of regional transmission facilities.
- Low-cost sensors and software were to be developed for use with a high-speed communication system that allows utilities and eventually regulators to monitor the status of regional transmission and distribution lines.

Actual Outcomes:

- Two PMUs installed in Southern California Edison (SCE) with communication systems resulted in data collected at a very high speed from all the monitoring sites for viewing grid disturbance data of the Bonneville Power Administration in Oregon at SCE in Southern California.

Project Title: USAT MOD-2

Contract #: 500-97-012-13

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$1,000,000

Contractor Project Manager: Bob Yinger, (626) 815-0508

Commission Contract Manager: Linda Davis, (916) 654-3848

Project Description: The purpose of this project was to promote development of the USAT satellite communications system to deliver high-reliability communications for utility

supervisory control and data acquisition (SCADA) systems under all types of weather conditions. SCADA systems allow a utility to monitor and control its transmission and distribution system to insure high reliability. Traditionally, communications was accomplished by leased or private telephone lines, microwave, fiber optic cable or radio. The use of satellite communications needs to be very cost-effective in remote areas and capable of collecting high speed SCADA data from any location in California no matter how remote. This data would not be available if conventional communications technologies were used.

This SCADA data is valuable in insuring that the highest reliability is maintained for the California transmission and distribution systems by enabling real-time monitoring of system loading and quick execution of control commands during normal and emergency conditions. Because of the system's high reliability and "communications anywhere" capability, it is invaluable during major fires, storms and earthquake emergencies. Communications during these emergencies is valuable in locating problems, assessing damage and returning equipment to service quickly. The ULTRA-NETTM remote terminals are easily installed and can be in service within a few hours to help reduce restoration time after a catastrophic event.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by providing accurate electric grid monitoring information on power supply disruptions;
- Improving the energy cost/value of California's electricity by reducing maintenance costs and restoration time;
- Improving the environmental and public health costs/risks of California's electricity by eliminating the need for service vehicles to visit remote sites on a regular basis. [This will result in a reduction of over three million vehicle miles (250 to 500k miles per year) resulting in fuel conservation and a corresponding reduction in environmental pollution]; and
- Improving the safety of California's electricity by allowing communications to be restored quickly when the infrastructure for other systems has been damaged or during catastrophic events.

Proposed Outcomes:

- Deliver high-reliability data between SCADA systems of electrical transmission and distribution systems under all types of weather conditions using satellite communications that are cost effective in remote areas.

- Develop a satellite communications system capable of collecting high speed SCADA data from any location in California no matter how remote to make data available beyond that of conventional communications technologies and enabling real-time monitoring.

Actual Outcomes:

- The system operated successfully, but more field operation is required before it can be considered a commercial product.
- To increase the commercial potential of the system, the cost of the remote terminals needs to be reduced since many remotes and only one hub is required in a complete system.
- Restoration time for communication to remote areas can be greatly improved since conventional restoration can take days, while the restoration of communications with USAT is accomplishable within hours.

Project Title: ENERGY SOURCE STABILIZER (ESS)

Contract: 500-97-012-14

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$250,000

Contractor Project Manager: Mohan Kondragunta, (626) 815-0507

Commission Contract Manager: Linda Davis, (916) 654-3848

Project Description: This project developed and demonstrated an Energy Source Stabilizer (ESS) that functions through a generating machine governor or other electronics-controlled power device to stabilize electrical frequency oscillations between various areas. Inter-area oscillations can cause very wide spread and costly power outages that may last for many days. Control of these dynamic oscillations through the generating machine governors is more effective and inexpensive than the existing power system stabilizers that function through the generating machine excitation system. Once proven, the ESS units can be installed on all generating machines having state-of-the-art rapid response governors.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing the incidence of large-scale power outages; and
- Improving the energy cost and value of California's electricity by providing a low-cost means of improving system reliability.

Proposed Outcomes:

- Stabilize low frequency dynamic system oscillations by modulating the real power of generators, thereby improving system stability and reliability.

Actual Outcomes:

- Two Energy Source Stabilizers (ESS) were installed at Alamitos Generating Station in Southern California and ESS performance was monitored during system disturbances to validate the working of ESS.
- The ESS operated as expected to dampen oscillations that otherwise may have increased to cause a widespread power outage.
- Multiple ESS units need to be installed throughout the Western Systems Coordinating Council (WSCC) system to achieve the reliability benefits possible with this technology. It is estimated that the increase in energy import capability due to the reliability improvements of installing ESS can save California electric customers approximately \$15-20 million per year.

Project Title: SUBSTATION RELIABILITY

Contract #: 500-97-012-15

Contractor: Edison Technology Solutions (ETS)

Contract Amount: \$215,000

Contractor Project Manager: Alonso Rodrigues,
(626) 302-8423

Commission Contract Manager: Linda Davis,
(916) 654-3848

Project Description: The purpose of this project was to develop an intelligent alarm analysis and diagnostics system, the Alarm Analyzer. The system simplifies thousands of pieces of information and alarms during an emergency condition, such as a regional system breakup due to a fault. In a matter of seconds, the operator is presented with only the relevant and highest priority information on system status and a recommended course of action. This compares to hours or days to do the same manually.

Voice data and command entry is established in control room consoles. During system disturbances, switching and other load and grid operations must be executed quickly and accurately. Speech recognition tools being adapted and evaluated through this project will free the operator from the keyboard to permit data entry and commands by voice. This project improves substation system efficiency, reliability and capacity and reduces operation and maintenance costs. This project helps electrical system operators to provide a much

quicker response time during transmission system breakup and disturbance.

The Alarm Analyzer improves the accuracy of control room operator decisions by assisting in quickly identifying the type of fault and accurately identifying its location. This information is essential in reducing the amount of outage time and costs to the users and the utilities. Crews can be dispatched with the correct materials for repairs to the precise trouble location and system reconfiguration can be implemented immediately to restore service through alternate routes.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by reducing restoration and fault analysis time from hours or days to minutes;
- Improving the energy cost/value of California's electricity by reducing operations and maintenance costs; and
- Improving the environmental and public health costs/risks of California's electricity by reducing the risk of operation mistakes during power disturbances.

Proposed Outcomes:

- Complete the initial stage of development of an intelligent alarm analysis and diagnostics system to automatically classify and filter the thousands of pieces of information and alarms generated during an abnormal event on the grid, such as a regional blackout caused by a fault.
- Investigate the feasibility of the Alarm Analyzer tool.
- Implement voice recognition technology and evaluate its benefits in the entry of data and commands into a computer or other device in control rooms and other applications.

Actual Outcomes:

- Southern California Edison (SCE) completed its objectives by developing the Alarm Analyzer tool, implementing voice recognition technology, and conducting successful demonstrations of each.
- Use of the Alarm Analyzer tool reduced the time required to produce an accurate diagnostic of an event from several hours or days to less than two minutes. These results are based on simulations of actual events occurring at the Dalton Substation.
- The voice recognition tools evaluated in this project resulted in a productivity increase of at least 200 percent in entering information into a computer file, with an accuracy rate greater than 97 percent. These results are based on a comparison between keyboard entry methods and voice input.

- Operations and maintenance costs are reduced by improving productivity through data entry and control of computers via voice. Dictating directly to the computer was found to improve productivity by at least 200 percent and greatly simplified multi-tasking for control room operators, line patrols, and office personnel.

Project Title: DEVELOPMENT OF A REAL-TIME MONITORING DYNAMIC RATING SYSTEM FOR OVERHEAD LINES

Contract #: 500-98-034

Contractor: Engineering Data Management, Inc. (EDM)

Contract Amount: \$499,402

Match Funding: \$510,019

EDM: \$230,019

EPRI: \$280,000

Contractor Project Manager: Andrew H. Stewart,
(970) 204-4001

Commission Contract Manager: Linda Davis,
(916) 654-3848

Project Description: The purpose of this project is to increase the efficient use of overhead transmission lines by developing a monitoring system which provides instantaneous information to electric grid operators about monitored transmission lines' power-carrying capacity and safety code compliance related to power line ground clearance requirements.

This project will improve the safety and the reliability/quality of California's electricity by providing a system to monitor transmission line-to-ground clearance thereby avoiding fires and electrical shock hazard and reducing power outages caused by sagging lines. The project also improves the efficiency and power carrying capability of monitored lines, thereby improving line utilization and reducing costs of power delivery and reducing losses.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by providing a system to reduce power outages caused by sagging lines;
- Improving the energy cost/value of California's electricity by improving the efficiency and power carrying capability of monitored lines and reducing costs of power delivery;
- Improving the environmental and public health costs/risks of California's electricity by reducing losses and avoiding fires; and

- Improving the safety of California's electricity by monitoring transmission line-to-ground clearance thereby avoiding electrical shock hazard.

Proposed Outcomes:

- Improving the ability to monitor the line to ground clearance of transmission lines should help avoid fires and electrical shock hazard and reduce power outages caused by sagging lines.
- Reduce energy cost by improving the efficiency and power carrying capability of monitored lines, thereby improving line utilization and reducing costs of power delivery as well as reducing losses.
- Able to measure clearances and sags with an accuracy of better than ± 2 inches.
- Capable of threefold use:
 - Real-time monitoring/dynamic rating;
 - Evaluating the performance of existing lines to re-rate their capability; and
 - Monitoring the status of clearances/sags in "safety critical" areas.
- Installation time for sensor system field hardware of less than six hours.
- Capable of operation in remotes sites through use of solar power supply plus capability for simple reconfiguration to AC power.
- Capable of reliable operation during daylight and at night.
- Capable of reliable operation in temperatures ranging from -10 degrees F to $+120$ degrees F.
- Capable of ready integration of additional devices for making ancillary measurements such as wind speed and ambient temperature.
- Capable of remote sensor system operation through cellular, radio, or satellite communication.
- Capable of autonomous remote reboot of hardware in case of an operational or environmental anomaly that causes proper operation to cease.
- The target maximum cost for a complete system is \$45,000, with additional sensor packages available for utilization with the system at a cost of \$15,000 each. These costs do not include installation labor and expenses, nor the costs for the computer, telephone line, and networking that will be required to support effective use of the system.

Project Status: The project is on schedule, within budget and is expected to achieve the proposed outcomes.

Project Title: DEVELOPMENT OF A COMPOSITE REINFORCED ALUMINUM CONDUCTOR

Contract #: 500-98-035

Contractor and Major Subcontractors: W. Brandt Goldsworthy & Associates, Inc.

Contract Amount:	\$75,000
Match Funding:	\$185,000
Los Angeles Regional Technology Alliance:	\$65,000
DOE-Energy Inventions and Innovations:	\$55,000
WBG&AI:	\$65,000

Contractor Project Manager: W. Brandt Goldsworthy, (310) 375-4565

Commission Contract Manager: Linda Davis, (916) 654-3848

Project Description: The purpose of this project is to improve the reliability and capability of California's transmission and distribution system by developing a stronger and lighter conductor to replace these aging and overloaded power lines. Specifically, this project will develop a composite reinforced aluminum conductor (CRAC) to replace conventional conductors made from aluminum wires wrapped over a core of steel strands (called aluminum conductor - steel reinforced (ACSR) conductors). Many miles of California's overhead electricity transmission lines have reached the end of their service lives or are being stressed beyond their design limits due to load growth and heavy power transfers across longer distances. This technical development is very timely as the current age of transmission lines ranges from 30-70 years.

W. Brandt Goldsworthy and Associates, Inc. of Torrance, California, with additional match-funding support from the DOE and private industry, is reconfiguring aluminum conductors around a lightweight composite strength member whose weight is approximately 25 percent of the traditional steel strength member. The resulting lightweight conductor can be optimized for reduced sag and increased ampacity. CRAC conductors can withstand adverse weather and high load conditions, thereby avoiding power outages caused by line sagging and swinging, high winds and ice buildup.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by avoiding power outages caused by line sagging and swinging, high winds and ice buildup;
- Improving the energy cost/value of California's electricity by reducing losses and the costs of replacing conductors;
- Improving the environmental and public health costs/risks

of California's electricity by reducing the need for new transmission lines; and

- Improving the safety of California's electricity by significantly reducing the potential for line clearance violations.

Proposed Outcomes:

- Design, fabricate and test a robust, practical and cost-effective composite reinforced aluminum conductor.
- Target market price for CRAC is \$1.00 per product pound, which is approximately the cost of aluminum conductors which are steel reinforced.
- Five percent more electrical conductivity, compared to steel reinforced aluminum conductor.
- Reduced mechanical elongation (line sag) at high operating temperatures.
- 250 percent stronger than steel reinforced aluminum conductor.
- 75 percent lighter than steel reinforced aluminum conductor.

Project Status: The project is on schedule, within budget and is expected to achieve the proposed outcomes.

Project Title: 2 KWH FLYWHEEL ENERGY STORAGE SYSTEM

Contract #: 500-98-036

Contractor: Trinity Flywheel Power

Contract Amount: \$1,057,406

Match Funding: \$1,062,494

Contractor Project Manager: John Eastwood, (415) 362-0634

Commission Contract Manager: Jamie Patterson, (916) 654-4819

Project Description: The purpose of this project is to demonstrate a two-kWh flywheel energy storage system for distributed generation and load shifting that will be directly scaleable to ten kWh. The technical objective of this project is the design, fabrication, and operation of a cost-effective composite flywheel having emphasis upon both high specific energy and low idling losses.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by providing a load shifting technology that can be used during peak load periods.

Proposed Outcomes:

- One operating two-kWh flywheel energy storage system for distributed generation and load shifting that will be directly scalable to ten kWh.
- Complete the transition from further development of the technology to volume manufacturing.

Project Status: The project is on schedule, within budget and is expected to achieve the proposed outcomes.

Project Title: LIGHT ACTIVATED SURGE PROTECTION THYRISTOR (LASPT) FOR DISTRIBUTION SYSTEM RELIABILITY

Contract #: 500-98-038

Contractor and Major Subcontractors: Energy Compression Research Corporation (ECRC) was the contractor. On October 6, 1999, the contract was novated from ECRC to OptiSwitch Technology, Inc. (OTC). Subcontractors include Silicon Power Corporation; SRI International; and Telecom Data.

Contract Amount: \$494,239

Match Funding: \$93,292 (ECRC)

Contractor Project Manager: Dr. David Giorgi, (858) 452-8787, ext. 125

Commission Contract Manager: Jon D. Edwards, (916) 654-4851

Project Description: The purpose of this project is to determine whether it is technically and economically feasible to replace electronically activated surge protection thyristors currently installed on high-power transmission and distribution systems with the improved custom light activated surge protection thyristors. Specifically, this Contractor will design, fabricate, and laboratory test the LASPT to determine if it has superior technical performance characteristics to that of a conventional thyristor.

This project contributes to the PIER program objective of:

- Improving reliability of California's electricity system by lowering the state's vulnerability to catastrophic outages by preventing cascading power failures due to rapid surges. This project also contributes to the PIER Program's strategic energy research objective under the revolutionary science attribute of designing and manufacturing a unique optical coupling to complete the development of the custom LASPT.

Proposed Outcomes:

- Design, fabrication, and laboratory testing of a light activated surge protection thyristor;
- Exhibit a surge response rate of 10 k (kilo) amps per microsecond (10 kA/ms);
- Exhibit a peak current rate of 15 k (kilo) amps (15kA); and
- Exhibit minimum blocking voltage capability of 2700 volts.

Project Status: The project is on schedule, within budget and is expected to achieve the proposed outcomes.

Project Title: INTELLIGENT SOFTWARE AGENTS FOR CONTROL & SCHEDULING OF DISTRIBUTED GENERATION

Contract #: 500-98-040

Contractor and Major Subcontractors: Alternative Energy Systems Consulting, Inc., and Reticular Systems Inc.

Contract Amount: \$554,010

Match Funding: \$34,347

Contractor Project Manager: Gerald L. Gibson, (619) 560-7182

Commission Contract Manager: Jamie Patterson, (916) 654-4819

Project Description: The purpose of this project is to demonstrate the use of intelligent software agents for control and scheduling of distributed generation. The California Alliance for Distributed Energy Resources (CADER) projects that distributed generation could supply 20-40 percent of the estimated capacity that will be needed in California to both replace retired generating plants and to meet increased loads.

This project supports the PIER Program objective of:

- Improving the reliability/quality of California's electricity by enabling a greater participation by owners of distributed energy resources through the use of intelligent software agents for control and scheduling of distributed generation. This will reduce distribution system congestion and avoid distribution line losses.

Proposed Outcomes: A demonstration of intelligent software agents successfully controlling and scheduling distributed energy generation resources.

Project Status: The project is on schedule, within budget and is expected to achieve the proposed outcomes.

Project Title: SAGGING LINE MITIGATOR (SLIM)

Contract #: 500-98-042

Contractor and Major Subcontractors: Material Integrity Solutions, Inc. (MIS) and Dariush Shirmohammadi, Ph.D.; Expert Power Engineering Consultant; C. Hari Dharan, Ph.D.; Expert Composite Materials and Design Consultant; and Zorica Pantac-Tanner, Ph.D.; Expert Electro-magnetics Consultant.

Contract Amount: \$900,000

Match Funding: \$303,920

Contractor Project Manager: Dr. Manuchehr Shirmohammadi, (510) 594-0300

Commission Contract Manager: Jon D. Edwards, (916) 654-4851

Project Description: The purpose of the SLIM project will develop and test a sagging line mitigator to automatically counteract the sagging of high voltage transmission lines due to high ambient temperature and current flows. The product to be developed has the potential to revolutionize treatment of overhead transmission lines for both retrofitting of existing lines and construction of new lines. It will significantly reduce the risk of forest fires and brownouts caused by

sagging lines, increase the efficiency of energy transfer, delay the need for additional line capacity and delay the construction of new lines. Used on new lines, this product will allow reduced tower height and/or increased distance between towers.

This project supports the PIER Program objectives of:

- Improving reliability and quality of California's electricity system by reducing the risk of brownouts (the curtailment of electric deliveries due to line capacity constraints) and power supply interruptions;
- Improving the safety of California's electricity by significantly reducing the risk of electrocution and fires caused by sagging transmission and distributions lines; and
- Reducing the environmental and public health risks/costs of California's electricity system by avoiding the need to build additional transmission towers.

Proposed Outcomes:

- Complete design and analysis work for the proposed SLIM device;
- Conduct rigorous prototype testing for applicability; proof of concept and design refinements; and
- Develop manufacturing plans for the SLIM device.

Project Status: The project is on schedule, within budget and is expected to achieve the proposed outcomes.

PROJECTS FUNDED IN 1998 THROUGH COLLABORATIVE RESEARCH WITH THE ELECTRIC POWER RESEARCH INSTITUTE

Project Title: TARGET 21 MUNICIPAL WATER AND WASTEWATER

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Nitrate Removal Tech; PERKINS DBA DAVID; RICE International ; American Water Works Research Foundation; Black & Veatch; BOC Group, Inc; Camp Dresser & McKee; CH2M Hill; City of Houston, Texas; Clean Earth Technologies; Edison Technology Solutions; ESG International, Inc.; Hazen & Sawyer; HDR ENGINEERING, INC.; Kennedy/Jenks Consultants; Malcolm Pirnie Inc.; McAllen Public Utilities; Nitrate Removal Technologies; ProWrite, Inc.; Tennessee Valley Authority (TVA); University of Missouri-Columbia; University of New Hampshire; Washington University; West Chester Area Municipal Authority.

Contract Amount: 1999: \$157,500
2000: \$157,500
Total: \$378,000

Match Funding: 1998: \$1,379,214
1999: \$1,790,212
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Keith Carns, (314) 935-8598

Commission Project Manager: Wendell Bakken, (916) 654-4042

Commission Contract Manager: Jane Heinz, (916) 654-4502

Project Description: The purpose of this project is to provide technology and information on the cost effective use

of energy to deliver clean drinking water, treat, dispose, and reuse wastewater, and dispose of residuals, biosolids, and brines. Advanced technologies include ozonation of drinking water, freeze/thaw waste conditioning, and ultraviolet (UV) disinfection techniques. The available supply of high quality water and sufficient wastewater treatment capacity are essential to future economic development of a region. On average, municipal water/wastewater industries comprise approximately 3 percent of the total electrical load (approximately 75 billion kWh per year). Due to population increases, the load for these industries is projected to increase by more than 20 percent over the next 15 years. Of key interest in this EPRI target is the need for clean drinking water and the use of water for industrial purposes.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing advanced technologies to cost effectively deliver clean water, and process and dispose of wastes derived from water treatment; and
- Improving the public health costs/risks of California's electricity ratepayers by providing technologies that effectively purify water and wastewater.

Proposed Outcomes:

Increase the potential for application of ozonation of drinking water

- Provide user manual, operating protocol for field tests, and other implementation tools to expand application of ozonation at a water-treatment technology.
- Provide educational information on the cost-effectiveness of ozone as an alternative to chlorine disinfection, the resulting improvements in water quality and environmental impacts, and low maintenance costs.

Increase the potential for application of advanced technologies for water and wastewater treatment.

- Provide information from case studies on use of membrane separation technologies to solve water quality problems.
- Freeze/Thaw Conditioning of Water Residuals and Industrial Sludges: Disposal of sludges and residuals accounts for up to 30 percent of plant operating costs. This electrotechnology can cut disposal costs while significantly increasing electric load. Technical Publication 4Q99.
- Industrial Wastewater Technology Applications: Rising sewer charges are forcing many industries to seek alternative ways to treat or reuse wastewater. These technology applications will support industrial customers in addressing these issues. Technical Publication 4Q99.

- Ultraviolet (UV) Light Technology Applications in Water and Wastewater: It is estimated that UV light applications will grow from 6 percent currently to 30 percent penetration in U.S. wastewater plants by the year 2008. This project will advance the markets for UV disinfection of wastewater into potable water and industrial applications. Technical Publication 4Q99.
- Advanced Energy Recovery System to Improve Reverse Osmosis (RO) systems: This project is a demonstration of a new reverse osmosis (RO) energy recovery system. The lower costs resulting from this system will make RO an attractive option for new water treatment plants. Technical Publication 3Q99.
- Supervisory Control and Data Acquisition (SCADA) Control of Water and Wastewater Systems: This project will optimize the operation of water and wastewater systems, particularly by coordinating equipment operation with real-time pricing and, by developing standard data and equipment protocols. Technical Publication 3Q99.
- Electron Beam Treatment of Municipal and Industrial Water & Wastewater: Electron beam (e-beam) treatment shows tremendous promise for disinfection and advanced oxidation of water and wastewater. This project focuses on improving the economic feasibility of e-beam technology. Technical Publication 4Q99.

Increase the potential for application of Pulsed UV for Water/Wastewater Disinfection.

- Providing research reports, full-scale demonstration, and information products on advantages of pulsed UV water treatment as an effective alternative to conventional technology using continuous-wave UV to treat surface water and to inactivate cryptosporidium and other waterborne pathogens.

Project Status: The project has been extended until 2000. The project is within budget and is expected to achieve desired results.

Project Title: TARGET 22 FOOD PROCESSING

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; APOGENICS, INC.; C&S AgriSystems; Cornell University; Edison Industrial Systems Center; Iowa State University; New York State Energy Research & Development; Plumrose USA Inc; ProWrite Inc; Sandridge Food Corporation; University of California, Davis; University of Minnesota; Washington State University; WaterTech Partners; GRAHAM DEE; IMBROGLIO CURES INC.

Contract Amount: 1999: \$120,000
2000: \$120,000
Total: \$240,000

Match Funding: 1999: \$426,810
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Myron Jones, (650) 855-2993

Commission Project Manager: Ricardo Amon,
(916) 654-4019

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to provide California's food processing industry with new electrotechnologies that increase energy efficiency and reduce environmental impacts that can help keep this sector of the California economy productive and energy efficient. Concerns about the worldwide environment and demand for food are just a few of the many challenges this important sector of California industry must meet to stay competitive. A competitive food processing industry is more likely to stay in California and ensure that California's rapidly growing population has a safe and adequate food supply. EPRI offers the latest tools and information such as technical services, communication tools, and innovative initiatives that focus on food safety—a top priority among consumers and regulators today. Electrotechnologies like ozonation and pulsed power for sanitation are some of EPRI's state-of-the-art solutions to the industry's most pressing concerns.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by developing and implementing technologies that improve productivity and energy efficiency for food processing industries; and
- Improving the environmental and public health costs/risks of California's electricity by reducing fresh water supply needs, plant wastewater discharge, and improved food sterilization.

Proposed Outcomes:

Improve the competitiveness of the California food processing industry through implementation of technologies which improve energy efficiency, reduce environmental impacts, and provide safer, more productive processes.

- Ozone Applications in Food Processing Initiative (Fumigation, Disinfection, and Water): Ozone has achieved Generally Regarded As Safe (GRAS) status. This initiative supports research, development, and demonstrations at food processing facilities.

- Technical Assistance: The Commission can foster on-site technical support to California food processors to examine opportunities for improving plant operations including energy efficiency, process water recycling, and improved product quality.
- Customized Training/Technology Briefings/Workshops: The Commission can foster training for food processor plant staff or engage them in specific technology-focused seminars or issue-based conferences for decision makers.
- Technology Communication Resources (Newsletters/Monthly Briefings/Audio Magazine/Custom Mailings): A report on trend/issue evaluations of the food segment industry and communications materials will aid the Commission in developing its strategy to influence energy related actions with this important California industry.
- Sector Overviews: Major food sector overviews for product costs, energy costs, and energy consumption will aid the Commission in focusing on which industry sectors have the greatest potential for energy savings.

Project Status: The project has been extended until 2000. The project is within budget and is expected to achieve desired results.

Project Title: TARGET 23 CHEMICALS, PETROLEUM AND NATURAL GAS

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Advanced Resources International, Inc; Chemicals & Petroleum Management, Inc.; Edison Technology Solutions; El Paso Energy Corp.; Hawaiian Electric Company Inc; Kennedy/Jenks Consultants Inc; Lockheed Martin Energy Research Corporation; Massachusetts Institute of Technology; Niro Process Technology; Taratec Corporation; University Of Florida; University of Patras; Veritech, Inc; ISOPro International; Optima Engineers & C, ProWrite Inc.; Resource Dynamics

Contract Amount: 1999: \$125,000
2000: \$125,000
Total: \$250,000

Match Funding: 1999: \$582,206
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Ammi Amarnath,
(650) 855-2548

Commission Project Manager: John Sugar
(916) 654-4563

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to provide chemical and petroleum companies methods to cut energy costs while improving productivity and yield. It will also provide information for companies reviewing options for generating on-site electricity and seeking the latest and most cost-effective advances in pollution control. To stay productive and profitable, decision-makers in this market sector must address a host of economic and environmental concerns. EPRI provides information and technical expertise on advanced systems for wastewater reduction, soil remediation, and fluid transport to increase the value of electricity as this segment of California industry enhances environmental compliance and lowers operating costs.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing information on reducing wastewater discharge and improving soil remediation techniques for the chemical, natural gas, and petroleum industry; and
- Improving the environmental and public health costs/risks of California's electricity by providing information to reduce the impacts on the environment by the chemical, natural gas, and petroleum industry.

Proposed Outcomes:

Encourage the use of ozonation in Process Industries through a demonstration project at an industrial site in California.

- State of the Art Cooling Tower Ozonation Demonstration: Demonstrate the technical and economic viability of using ozone as a cooling tower treatment in place of chlorine, bromide and other toxic substances, while maintaining tower heat transfer efficiency.

Improve the understanding of power quality needs of large industrial complexes.

- Power Quality (PQ) Analysis, Survey and Seminar: EPRI will do a full power quality audit at a California industrial facility to understand the end use power quality needs within large industrial complexes. The benefits will be public and worker safety and improved economics. The project examines how to target PQ protection devices within a deregulated electricity market. EPRI will provide a seminar for Process Industries on power quality.

Provide information to encourage reduction of wastewater for process industries.

- Deliver Wastewater Reduction Technologies for a Process Industries Guidebook documenting the application

potential, benefits, and costs for a variety of waste reduction technologies. Industry-specific reference for comparing technologies prior to purchase. The guidebook is designed to help select technologies to improve operations, increase profits, and reduce costs.

Provide marketing and communication tools to increase use of energy efficient technology in chemicals and petroleum process such as:

- Freeze Concentration of Hazardous Wastes
- Process Water Reduction Using Mass Pinch Technology
- DOE's Industry of the Future Conference
- Supply Side Management (Electricity & Gas Sales, Distribution System Reliability, Cogeneration, Tariff Analysis, Asset Management) Marketing Kit
- Center Update: Chemical & Petroleum Industry Happenings

Provide information to increase use of energy efficient technologies in chemical, natural gas, and petroleum processes.

- Provide results on technologies for enhanced recovery of oil.
- Deliver report: Produced Water in Crude Oil Recovery: Converting a Potential Environmental Problem to Valuable Water Resource. Documentation of a project to demonstrate a treatment train that would treat excess produced water for export from the oil field and convert the water to a potable water resource for use by the public.
- Deliver report: Electric Compressor Guidebook. Electric motor driven compressors in the gas industry may consume as much as 30 MW per station. As a comprehensive reference, this guidebook offers both electric and gas industries valuable information to support the myriad of decisions associated with implementing an electric drive system.
- Provide In Situ Soil Remediation using Electric Heating Thermal Desorption Technology: Demonstration and economic evaluation of an advanced Shell technology; remediation of contaminated soil at chemical and petroleum refining sites, increased environmental compliance, reduced operating costs.
- Provide Environmental Impacts on Gas Pipeline Compressor Economics: Economic analysis of various classes of compressors and related equipment, operation methods for environmental compliance, tool for cost comparison of components and procedures, increased compliance with air quality regulations and reduced costs.

Project Status: The project has been extended until 2000. The project is within budget and is expected to achieve desired results.

Project Title: TARGET 26 AGRICULTURE

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Edison Technology Solutions; Electrochemical Design Associates; G & L AgriTec; Hawaiian Electric Company Inc; North Carolina State University; ProWrite Inc; Purdue University; SoilZone, Inc.; Texas State Technical College; University of Georgia Research Foundation Inc; Berning Jonne L; Soilzone Inc.

Contract Amount: 1999: \$90,000
2000: \$90,000
Total: \$180,000

Match Funding: 1999: \$292,716
2000 Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Myron Jones, (650) 855-2993

Commission Project Manager: Ricardo Amon,
(916) 654-4019

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to offer a complete package of advanced energy solutions and technical support to increase farm production and reduce costs. U.S. farms spend about \$12 billion each year for energy. Approximately \$3.8 billion of that goes toward electricity purchases. Efficient use of electricity has a critical impact on profitability. Today's farmers and agribusinesses rely heavily on advanced technologies and science to turn a profit. Where once farmers turned a watchful eye to the sky for signs of rain, satellites now give them detailed snapshots of weather conditions around the country. Farmhands have been replaced by energy-efficient motors and other electro-technologies to the tune of 44 billion kWh of electricity consumption annually. This EPRI target also provides marketing communications tools to provide access to these energy solutions to agribusinesses.

This project supports the PIER Program objectives of:

- Improving the energy cost/value of California's electricity by providing energy solutions for agribusinesses to increase farm production and reduce costs; and
- Improving the environmental and public health costs/risks of California's electricity by demonstrating the use of ozone

as a replacement for chemicals such as methyl bromide for purification, fumigation, and disinfection.

Proposed Outcomes:

Increase the potential for use of ozone in place of chemicals or other methods in agriculture.

- The fresh fruit export business is a \$2 billion business in California. The fruit must be fumigated prior to packing to keep the fruit fresh and to keep pests out. Thirty percent of shipments can be lost if not fumigated. Beginning in 2002, the current method of fumigation, methyl bromide, will not be accepted by many countries importing our goods. This project has tentatively demonstrated that ozonation can be used in place of methyl bromide for fresh fruit fumigation. If ozonation is used for only 10 percent of the fruit exported, then 3 percent the \$2 billion business is maintained (\$66 million/year). If all fruit exported is fumigated by ozonation, the fresh fruit industry would be saved the potential loss of 1/3 of the \$2 billion market, or \$660 million.

- Field trials using ozone as a soil fumigant in place of methyl bromide.
- A handbook to be used in teaching workshops on ozone disinfection in agriculture.

Provide experience and knowledge on innovative technologies and practices to increase production and reduce costs in agribusiness.

- Drip Irrigation Manual: Manual containing methodologies for installing drip irrigation and monitoring methods for soil moisture.
- Aquaculture Training: Training courses to provide experience in setting up and operating aquaculture units.
- Power Quality Assessments: Brochure on power quality problems and solutions, and guidelines for agribusiness.

Increase the use of energy efficient technologies and practices in agriculture.

- Delivery of a report on the continuing refinements of a new and unique method for grain harvesting, especially for small farms with a short harvest seasons. The McLeod Harvest System provides an innovative utilization of electrical energy to clean and mill grain.
- Delivery of a report entitled "Agricultural Electrical Load: Identification and Strategies for Expansion: A Preliminary Investigation of Energy Consumption in the Production Agriculture Market Segment". This report documents economic and operating characteristics of the various

segments of the agricultural sector. Such knowledge will enable deployment of innovative and useful electro-technologies focused on the segments of the farming industry with the greatest potential for efficiency improvement and cost reduction.

Project Status: The project has been extended until 2000. The project is within budget and is expected to achieve desired results.

Project Title: TARGET 56 GRID OPERATIONS & MANAGEMENT

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; EPRI Conference Blau; ABB Systems Control; Bailey Network Management; Bonneville Power Administration; Cegelec ESCA Corporation; Decision Systems International; Duquesne Light Company; General Physics Corporation; General Reliability; Houston Lighting & Power Company; Incremental Systems, Inc.; Iowa State University; Kansas City Power & Light Company; KEMA Consulting, KEMA-ECC, Inc; Oracle Corporation; Pattern Recognition Technologies; Potomac Electric Power Company; Quality Training Systems; Siemens Energy and Automation, Inc.; Siemens/Empros; TU Electric Company; University of Liege; Utility Consulting International; V&R Company; Energy Systems Research; Warsaw University of Technology; Washington State University.

Contract Amount: 1999: \$225,000
2000: \$225,000

Total Contract: \$450,000

Match Funding: 1998: \$4,838,558
1999: \$4,739,264
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Dan Sobajic, (650) 855-8537

Commission Project Manager: Don Kondoleon, (916) 654-3918

Commission Contract Manager: Jane Heinz, (916) 654-4502

Project Description: The purpose of this project is to support EPRI's collaborative program in Grid Operations and Management which is developing new tools and information to ensure that the power grid will be a gateway to efficient competition and the key to customer satisfaction. EPRI provides tools and information that provide guidance on how to respond to demands to safely push more power through the system without jeopardizing system security. EPRI's

products give system operators a clear view of real-time grid conditions, and allow them to make decisions that take into account maximum use of the grid as well as reliability of the system. Examples include vital resources to support operator training, real-time software for Energy Management System (EMS) control and operation, and seamless communication between Energy Management Systems and power plants.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity through innovative technologies, which help to balance the competing needs of maximizing the use of the grid while maintaining the security of the system.
- Improving the energy cost/value of California's electricity by merging new tools for grid functionality with information for operating in the new competitive marketplace. EPRI technology development programs will help to increase transmission capacity across constrained interfaces, thus reducing grid-operating costs, while enhancing system security.

Proposed Outcomes:

Enhance the transaction management capabilities of transmission system operations to allow increased transactions without impact on security.

- Deliver improved transmission reservation and energy transaction management software, thus enhancing the performance of the existing Open Access Same-time Information System (OASIS) system in response to new business needs. This enhanced transaction management software, including reservations, tagging, curtailment, and ancillary services, will expand the functionality and performance of the existing OASIS system.

Maximize energy transfers and increase energy flows across constrained interfaces.

- Deliver on-line software that calculates multi-area, simultaneous power transfer capabilities (On-Line Transfer Capability Evaluation -TRACE). TRACE will determine maximum available transfer capabilities, reliably maximize energy transfers and increase flows across constrained interfaces by 3 percent.

Increase the transmission system capacity.

- Deliver real-time EMS software that calculates stability and voltage limits using actual system conditions. These two software products, Dynamic and Voltage Security Assessment Software (DSA and VSA), grid management tools for voltage-constrained areas, can increase existing transmission capacity by 5 percent, thus reducing the need for new transmission construction. EPRI's Application

Program Interface (API) will accelerate integration of these and other applications into energy company energy management systems while reducing grid integration costs.

Project Status: The project has been extended until 2000. The project is within budget and is expected to achieve desired results.

Project Title: TARGET 57 GRID PLANNING & DEVELOPMENT

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; California Institute Of Technology; Canadian Electricity Association; Carnegie Mellon University; Cornell University; ESEERCO; Harvard University; Honeywell Inc; Howard University; Iowa State University; Michigan Technological University; Mississippi State University; New Mexico State University; P Plus Corporation; Power Technologies Inc; PSERC; Purdue Research Foundation; Southern Company Services Inc; Texas Engineering Experiment Station; University of Washington

Contract Amount: 1999: \$225,000
2000: \$225,000

Total Contract: \$450,000

Match Funding: 1998: \$4,838,558
1999: \$2,206,917
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Dan Sobajic, (650) 855-8537

Commission Project Manager: Don Kondoleon, (916/) 54-3918

Commission Contract Manager: Jane Heinz, (916) 654-4502

Project Description: The purpose of this project is to help grid planners have ample lead time to prepare for the occasional bulk power transfer. Presently, they are responsible for facilitating hundreds of electricity sales and purchases each day. Bids must be processed in near real time and congestion issues must be resolved on the fly. Grid planning is becoming increasingly complex and labor intensive. This situation is directly at odds with dwindling work forces and loss of experienced personnel and the public demand for lower cost energy. To address this situation, EPRI is providing advanced analysis tools and enhanced communication systems. EPRI's Grid Planning and Development program provides a comprehensive portfolio of technology solutions for coping with the short-, mid-, and long-term planning and design demands of a changing industry. While the industry continues to change, the need to

deliver reliable economical power will not. This target delivers planning aids and operator-training tools that improve grid utilization, reduce operating costs, and ensure system security.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by developing advanced analysis tools and enhanced communication systems which will enhance grid planning in today's high transaction environment while maintaining system security; and
- Improving the energy cost/value of California's electricity by improving grid utilization and reducing operating costs through the development and application of advanced tools and communications systems.

Proposed Outcomes:

Increase the reliability of the California transmission grid.

- Bring to the California grid the enhanced EPRI/DCG Electromagnetic Transients Program (EMTP) now used by more than 200 energy companies. The EMTP program simulates electromagnetic transients in electric power systems. The restructured EMTP is expected to reduce simulation and data preparation time by at least 30 percent. This project is cofunded, with a majority of funding coming from other DCG members.
- Bring to the California Grid the EPRI transmission reliability software (TRELSS). Delivering power at the lowest cost while maintaining an acceptable level of reliability requires careful transmission planning. EPRI's Transmission Reliability Evaluation for Large-Scale Systems (TRELSS) can be used to analyze and quantify the reliability of bulk power systems to help determine the need for new transmission facilities. System planners can use TRELSS program results to maintain the balance between transmission costs and reliability.
- Bring to the California Grid the EPRI package of power system analysis programs (PSAPAC). A system study is the first important step toward implementing Flexible AC Transmission System (FACTS) devices. The Grid Planning and Development Target will deliver the software, PSAPAC, to evaluate this beneficial technology. Several applications have shown that the use of these commercially available FACTS devices can raise existing capacity and reduce susceptibility to power disturbances.
- Bring to the California grid a means of metering and costing ancillary services. Previous work in ancillary services includes EPRI's efforts in developing metering and costing frameworks for ancillary services in 1998. In 1999, new work addresses the design and development of on-

line tools for the management and deployment of ancillary services. Such automated tools are necessary for the efficient scheduling, deployment, metering, and settlement of ancillary services.

Project Status: The project has been extended until 2000. The project is within budget and is expected to achieve desired results.

Project Title: TARGET 61 KNOWLEDGE-BASED CUSTOMER METERING; 61.1 TECHNOLOGY DEVELOPMENT; AND 61.2 MARKET RESEARCH AND SERVICES DEVELOPMENT

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Advanced Systems Associates; Hypertek, Inc.; Plexus Research Inc; Advanced Systems Associates; Arizona State University.

Contract Amount: 1999: \$333,125

2000: \$333,125

Total Contract: \$666,250

Match Funding: 1999: \$1,165,930

2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Dave Richardson,
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Commission Project Manager: Tom Tanton,
(916) 654-4515

Commission Contract Manager: Jane Heinz,
(916) 654-4502

Project Description: The purpose of this project is to provide electricity consumers with intelligent, time-of-use electric meters with built-in communications to enable utilities and their customers to utilize innovative activities such as automatic meter reading and energy utilization analysis. An important part of industry restructuring is customization of service—providing new choices and new benefits to individual clients. Some customers may be attracted by new ways to lower their electricity bills, while others are already demanding premium power quality. Beyond the differentiation of electricity service, new opportunities are also arising for convergence of multiple utility services—including gas, telephone, home security, and Internet access—through a single provider. In each of these areas, more sophisticated customer interface technology will be needed to meet the data collection and communications requirements of the utility service revolution with customers and suppliers benefiting from detailed load and billing information.

New meter technology applications are being developed using the EPRI collaborative research approach to reduce development costs and risks. New products developed during these projects will be available to members for beta testing and at preferential pricing when the product has been commercialized. A prepayment meter is under development to give customers the flexibility of prepaying specific sums, just as telephone cards are now doing. A non-intrusive appliance load monitoring (NIALMS) module will be developed to provide a better understanding of residential energy usage leading to improved time of day pricing service. Tamper detection and research hold out the promise of reducing the number of billing irregularities. This EPRI target also develops market research into new metering service packages. Members will have an opportunity to participate in the research and select the target customers and demographics. Market data and analysis developed during these projects will be available to members for early adoption.

This project supports the PIER Program objectives of:

- Improving the quality of California's electricity by providing advanced meters with the intelligence, flexibility, and communication capability to allow automated meter reading, real-time pricing, and energy management services.
- Improving the energy cost/value of California's electricity by enabling the delivery of value-added electricity services to customers through advanced meters.

Proposed Outcomes:

Produce a commercial product, the knowledge based meter, which is cost competitive with existing meters on an evaluated basis, while providing an array of additional services.

- Prototype testing, field trials, and bringing to market readiness a residential meter module for prepayment services.
- Deliver a final report, and bring to market readiness a non-intrusive appliance load monitoring module for the knowledge based residential meter.
- Develop a prototype of a light, commercial three-phase modular meter platform, conduct field trials, deliver a final report, and bring that meter platform to market readiness.

Understand residential customers responses to new types of services made possible by advanced meters and communications systems.

- Customers will be asked to indicate their interest in automatic billing to a credit card, itemized billing showing

energy consumption by major appliances, time-of-use rates, and single billing for multiple utility services.

- Deliver a final report on historical results of prepayment projects.
- Deliver a final report on response of residential customers to new types of services made possible by advanced meters and communications systems, e.g. automatic billing to a credit card, itemized billing showing energy consumption by major appliances, time-of-use rates, and single billing for multiple utility services.

Deliver complete metering solutions with the methodology on how to use them for maximum choice and value to customers.

- The knowledge-based meter will offer collaborative opportunities to test and implement new advanced metering devices and methodologies. EPRI technical expertise will help to evaluate and implement advanced metering solutions quickly and easily.

Project Status: The project has been extended until 2000. The project is within budget and is expected to achieve desired results.

Project Title: Targets: 64.0 DISTRIBUTED RESOURCES (DR) INFORMATION AND TOOLS FOR BUSINESS STRATEGY DEVELOPMENT; 64.3 DISTRIBUTION PLANNING TOOLS FOR DISTRIBUTED RESOURCES; AND 64.4 DISTRIBUTED RESOURCES AS A RISK MANAGEMENT HEDGE IN RETAIL PORTFOLIOS

Contract #: 100-98-001 #1

Contractor and Major Subcontractors: EPRI; Christensen & Associates, Inc.; Daniel Mann Johnson Mendenhall; Edison Technology Solutions; Electrical Distribution Design Inc; Energy Signature Associates, Inc.; Erin Engineering and Research, Inc.; Hagler Bailly Consulting, Inc.; Materials and Systems Research, Inc.; National Rural Electric Cooperative Association; NEOS Corporation; Ontario Power Technologies; Proton Energy Systems, Inc.; Raytheon Engineers & Constructors, Inc; Resource Dynamics Corporation; Utility Consulting International.

Contract Amount: 1999: \$350,625
2000: \$350,625

Total Contract: \$701,250

Match Funding: 1999: \$2,989,356
2000: Membership solicitation in progress, funding not yet known.

Contractor Project Manager: Dan Rastler, (650) 855-2521

Commission Project Manager: Jairam Gopal, (916) 654-4880

Commission Contract Manager: Jane Heinz, (916) 654-4502

Project Description: The purpose of this project is to provide the Commission with information and tools to enable California ratepayers and energy providers realize the full potential of DR-based business strategies. EPRI involvement in DR research provides the unique access and intelligence necessary to identify new markets niches, improve the use of generation and T&D assets, and evaluate DR-based solutions for commercial and industrial ratepayers and business opportunities for energy providers. The target focuses on creating integrated, dependable, packaged solutions and providing information to better understand the DR market, both locally and globally. This EPRI target provides information to support the planning and deployment of DR projects, understand the impacts of DR on utility distribution systems, and evaluate the integration, management, and control of DR technologies.

This project supports the PIER Program objectives of:

- Improving the reliability/quality of California's electricity by developing generation options for energy companies to utilize to provide unique solutions for their customers to address peaking power issues, to enhance their system reliability (system voltage control) and to assure power quality;
- Improving the energy cost/value of California's electricity by assisting in the development of innovative distributed generating technologies and strategies that potentially, provide lower delivered electricity cost than central station power; and
- Improving the environmental and public health costs/risks of California's electricity by assisting in developing fuel cell and other environmentally preferred DR technologies that can be utilized throughout the State, replacing traditional central station power.

Proposed Outcomes:

Enable the application of DR technologies in California by providing strategic information on the DR business environment, trends, technologies, customers, and markets. This information includes:

- EPRI's Distributed Resources Workstation: Enhancement and modification of an existing PC Windows-based program that has become an indispensable guide for selecting the DR options best suited for individual customer applications. The DR Workstation evaluates key

energy devices, models complex load shapes and energy rate structures, and is tied into a detailed database of product-specific characteristics.

- DR Strategic Overview: Briefings will be given by EPRI staff, and a report will be provided in both hard copy and electronic formats.
- Information for Executing DR Business Strategies: Reports will be developed for each of four key market segments.
- Intelligence Update: A quarterly newsletter will offer timely information on DR technologies, markets, and the regulatory environment.
- Requirements for DR Technologies for Specific Customer Segments: This report will describe customer energy needs in different market segments and outline strategies for addressing those needs through the use of DR technologies.
- TAG-DR Enhancements: Enhancements will be made to provide updated cost and performance information on DR technologies, and to expand information on related business aspects.
- Micro-Grid Evaluation: This assessment will report on technical, economic, and environmental issues associated with DR energy packaging.

Provide detailed information to allow distribution planners the ability to evaluate DR opportunities.

- Enhance EPRI-developed advanced analytical methods and software (the Area Investment Planning Tools) to help distribution planners develop capacity expansion investment plans that consider uncertainty and risk, and to optimize the use of DR within the distribution system.

Provide detailed information that allows for the analysis of DR application for energy service risk management.

- Provide a report that will describe where specific types of DR technology can be employed to provide risk management contracts. The report will provide a methodology for determining appropriate circumstances and calculating benefits of such contracts and will provide samples of risk management contracts.

Project Status: The project has been extended until 2000. The project is within budget and is expected to achieve desired results.

Contributing PIER Staff¹

¹ Being an inter-divisional program, the PIER Program involves many talented people from the Commission's administrative, technical, and management staff. This listing of PIER staff is not exhaustive but rather attempts to highlight those who have been the principal contributors to this program in 1999. Advance apologies to any PIER Program contributors who have been overlooked in this listing.

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Research, Development and Demonstration Committee Policy Advisors

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In addition to those listed above, the following Commission staff made substantial contributions to the PIER Program in 1999 in their special area of expertise:

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**Members of the
Independent PIER
Evaluation Panel**

Dr. Harold M. Agnew

is the retired President, General Atomics, and past Director of Los Alamos Scientific Laboratory. He was Science Advisor to the Supreme Allied Commander in Europe (1961-64) and a New Mexico State Senator from 1955-61. Dr. Agnew's honors and awards include: recipient of the Ernest Orlando Lawrence award, 1966; and the Enrico Fermi award, 1978. He is an elected member of the National Academy of Science, the National Academy of Engineering and Fellow of the American Association for the Advancement of Sciences.

Dr. Richard E. Balzhiser

retired in August 1996 as President and Chief Executive Officer of the Electric Power Research Institute (EPRI) in Palo Alto, California. He remains active in a President Emeritus role at EPRI in addition to serving on several industry boards and technical advisory committees. Dr. Balzhiser currently serves on a variety of boards and committees including the Energy Subcommittee of the President's Council of Advisors on Science and Technology, the Mobil Technical Advisory Committee, the Pacific Northwest Laboratory Advisory Committee, the Technical Advisory Board of the Massachusetts Institute of Technology Energy Laboratory, the Board of Directors for the Aerospace Corporation, the Board of Directors for Reliant Energy, and the Board of Directors of Nexant, LLC.

Dr. Patricia A. Buffler

is Dean Emerita and Professor of Epidemiology and Public Health at the School of Public Health, University of California, Berkeley. Dr. Buffler's research interests include epidemiology of cancer, specifically childhood leukemia and the effects of environmental exposures and genetic susceptibility. She serves on the Board of Directors, U.S.-Japan Radiation Effects Research Foundation, Hiroshima, Japan; the World Health Organization, Expert Advisory Panel on Occupational Health; the Board of Scientific Counselors for the National Center for Infectious Diseases; the U.S. Public Health Service Centers for Disease Control and Prevention, Task Force on Community Preventive Services; and the National Institutes of Health, National Advisory Council on Environmental Health Sciences. She is a fellow for the American Association for the Advancement of Science and the American College of Epidemiology and a member of the Institute of Medicine/National Academy of Sciences.

Dr. Linda R. Cohen

is Professor and Chair for the Department of Economics at the University of California, Irvine. Her fields of study are political economy, government regulation, government policy for science and technology, and positive political theory and law. Dr. Cohen has advised numerous federal departments and agencies on science policies, including the Departments of Energy and Commerce, the Office of Technology Assessment, and the Congressional Research Service and has served on several committees for the National Research Council. She has testified before state agencies and commissions, including the California Energy Commission and the California Constitutional Reform Commission.

Dr. John S. Foster, Jr.

is a retired Vice President of Science and Technology of TRW Inc. and former chairman of the Defense Science Board. Dr. Foster is currently Chairman of the Board of Directors of Pilkington Aerospace, chairman of Technology Strategies and Alliances, and consultant to TRW, United Technologies Corporation and Defense Group, Inc. His field of specialization is Industrial Manufacturing and Operating Systems Engineering and he is recognized for his work in technological leadership in defense research and engineering. Dr. Foster was the director for the Lawrence Livermore National Laboratory from 1961 to 1965. In 1965, Dr. Foster left the Lab for Washington and became Director of Defense Research and Engineering.

Dr. T. Kenneth Fowler

is Professor Emeritus in the Department of Nuclear Engineering, University of California, Berkeley. Dr. Fowler was chair of the Department from 1988 to 1994 and helped establish the multi-disciplinary Center

for Nuclear and Toxic Waste Management at UC Berkeley. His honors and awards include elected membership in the National Academy of Sciences; Fusion Power Associates Distinguished Career Award, 1995; and The Berkeley Citation, 1995. Dr. Fowler's areas of interest include fusion energy and energy research funding and the appropriate role of government in anticipating problems of energy-associated pollution and energy-associated competition for resources in its research funding policies.

Fred W. Kittler

is co-founder and co-president of Velocity Capital Management, an investment firm based in Palo Alto that provides equity funding for public and private technology and communications companies. Mr. Kittler was a research analyst and portfolio manager for J. P. Morgan Investment Management where he managed their portfolios of small technology and health science company stocks. He serves on the Visiting Committee On Advanced Technology for the National Institute for Standards and Technology.

Peter M. Miller

is a scientist with the Natural Resources Defense Council, Inc., a nonprofit national environmental organization. He is part of NRDC's energy project, which promotes the increased development of energy efficiency and other environmentally sound and cost-effective energy resources. His work involves research, analysis, and advocacy at the state, national, and international levels. He has participated in utility advisory committees in California, Hawaii, and the Pacific Northwest, in numerous proceedings before the California Energy Commission, the California Public Utilities Commission and the Northwest Power Planning Council, and in rulemakings before the U.S. Department of Energy. He was appointed to the California Board for Energy Efficiency in April 1997.

Dr. Esteban Soriano

established his own market research and program assessment company (The Resource Group), specializing in educational and economic assessments. He currently serves as Vice President for University Advancement at California State Polytechnic University, Pomona. He is an expert in communication strategies, economic impact studies and assessments, methodology and research design, and has extensive experience relating to electric and water utilities.

Dr. James L. Sweeney

is Professor of Management Science and Engineering, Stanford University. Dr. Sweeney has 25 plus years of experience working in energy and environmental economic issues, having worked at the federal level in the Federal Energy Administration in the 1970's. Dr. Sweeney has a long history of research and analysis in energy economics and technology issues. He has also contributed to a number of National Energy Plans, has been a member of numerous National Research Council committees and was one of the founding members of the International Association for Energy Economics.

Dr. Mary L. Walshok

is Associate Vice Chancellor - Extended Studies and Public Programs and Adjunct Professor in the Department of Sociology at the University of California, San Diego. She is the recipient of many awards and honors, among them a Kellogg Foundation national fellowship. Dr. Walshok serves on the board of the California Council for the Humanities and is a member of numerous community boards and professional associations including the San Diego Community Foundation, Girard Foundation, Eureka Communities, Foundation for Enterprise Development and ACCION.

Carl J. Weinberg

is currently a private consultant after retiring from Pacific Gas and Electric Company, where he worked for almost 20 years including eight years as Manager of Research and Development. Mr. Weinberg has been a contributor to the development and implementation of corporate, industry and national energy policies and strategies through research program management. He has extensive understanding of energy technologies, including commercial and potential renewable and conservation technologies, and has demonstrated effectiveness at accelerating technology readiness and proving technology benefits.